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Our New President

Sol. A. Bauer, Registered Engineer and Surveyor from the State of Ohio, was elected President of the American Congress on Surveying and Mapping for the year 1950. Mr. Bauer was born in Cleveland, Ohio, on March 11, 1898. He attended the public schools there and later entered Case Institute of Technology, where he received his B.S. degree in 1920 and his C.E. degree in 1923. In 1926 he established the Bauer Surveys Company in Cleveland, specializing in land surveying and civil engineering. He has been in private practice ever since.

SOL A. BAUER

Mr. Bauer became a member of the Congress in 1943 and since then has been extremely active in its affairs. He was responsible for the formation of the Technical Division on Property Surveys and became its first chairman. Under his wise guidance and leadership, the Division has made outstanding progress in raising the standards for property surveys, as well as in bringing about a better understanding of the problem of the property surveyor. Two comprehensive studies were made by the Division under his direction—"Technical Standards for Property Surveys" and "Equitable Fees for Property Surveys," both of which have been distributed by the Congress.

He is the author of a number of articles on the techniques and practices of surveying, including "Relative Angular, Linear, and Traverse Accuracies in City Surveys," published in the *Transactions* of the American Society of Civil Engineers; and "A—C Tables," which appeared in Searles, Ives, and Kissam's *Field Surveying*.

Mr. Bauer is a member of the Cleveland Society of Professional Engineers (President in 1942 and its present historian), the Ohio Society of Professional Engineers, the National Society of Professional Engineers, and the American Society of Civil Engineers. He is also a member of Tau Beta Pi and Sigma Xi engineering fraternities.

Mr. Bauer has received recognition as a result of his avocational interest in wood sculpture. Since 1927 his works have been displayed at exhibits in New York, Chicago, Philadelphia, Cleveland, Columbus, and Dayton. He is a member of the Fine Arts Advisory Committee and one of the trustees of the Ten Thirty Gallery, both of Cleveland. He is married and has two daughters.

A Message From President Bauer

AS the new president of the American Congress on Surveying and Mapping, I enter my office with some feeling of trepidation.

The Congress has attained a phenomenal success in its short life in establishing itself as the representative of the surveying and mapping profession in its entirety. While fully recognizing and appreciating the valuable contributions to surveying that have been and are being made by the American Society of Civil Engineers, the American Geophysical Union, and the American Society of Photogrammetry in their specialized fields, we must also face the urgent need for a general spokesman for the overall profession.

The representation of the Congress in the United Nations, the Pan American Institute of Geography and History, and the National Research Council is definite indication of the recognition the Congress has received. My personal apprehension, upon beginning my term of presidency of the Congress, rests upon the fact that it is my complete conviction that the ills, the problems, and the success of our profession are in the hands of the Congress. It is vital that the Congress accept its responsibilities, prove its importance, and move ahead to advance our profession to the point of recognition to which it is entitled.

The success of the Congress to date has been due to the missionary spirit of a band of men who are unselfishly devoted to the betterment of their profession. Although that list is steadily growing, it should and must increase in greater numbers. As recently expressed by one of our stalwarts, the motto "Every member bring in a member" should be changed to "Every member bring in a dozen members."

The Congress is performing a service that has never before been attempted for the surveying and mapping profession. This is particularly true for the practicing surveyor of this country. Standards and criteria of practice are being constantly established; exchanges of thought, methods and opinion are being published in our fine journal, SURVEYING AND MAPPING. For the first time, we have a current literature of and for the profession. Every practitioner within the surveying and mapping field owes it to his profession and to himself to belong to and support the American Congress on Surveying and Mapping.

Your newly elected president at this time can only promise his utmost efforts in behalf of the Congress. With the support of the membership—in committee work, in spreading the gospel of high professional standards, and in building up the membership—your incoming president has high hopes for a very successful year for the Congress.

SOL A. BAUER
President

Tenth Anniversary Meeting

AMERICAN CONGRESS ON SURVEYING AND MAPPING

June 21, 22, and 23, 1950, Shoreham Hotel, Washington, D.C.

THE TENTH ANNUAL MEETING of the American Congress on Surveying and Mapping will provide an appropriate climax to a decade of successful operation. The Congress has become a well-established professional and technical society of international standing. As a result of this growth and development, it now affords greater opportunities for members through its official publication, SURVEYING AND MAPPING; through the advancement of technical procedures and methods by the Technical Divisions; and through professional contacts and associations gained at regional and annual meetings.

The Tenth Anniversary Meeting will be the most important since the Congress was founded in 1941. All aspects of the three-day Meeting are being planned to provide for a maximum attendance. Members and guests will have the opportunity to hear internationally known speakers; to participate in the meetings of the Technical Divisions; and to hear formal papers and discussions presented at the plenary sessions on current topics selected by the Divisions. In addition to the technical and plenary sessions, social functions and entertainment will be provided.

The scope of the exhibits has been extended to include supplies, materials, and equipment in surveying and mapping and related fields. Information already available indicates that the number of exhibits will be twice that of previous meetings. These exhibits will enable members and guests to observe the latest designs in both domestic and foreign manufacture. Each exhibitor will have representatives available for demonstration and consultation during the three-day session.

Members and guests are expected to attend from most of the states, Canada, many Latin American nations, and a number of countries in the Eastern Hemisphere. Everyone interested in surveying and mapping or in any related subject should attend or be represented at the Tenth Annual Meeting.

A Preliminary Program will be released well in advance of the scheduled dates of the Meeting, and Advance Registration will be requested at that time. Since a capacity attendance is expected, full cooperation in this respect will be appreciated.

MURRAY Y. POLING,
General Chairman,
Annual Meeting

Proceedings of Technical Divisions
American Congress on Surveying and Mapping
Ninth Annual Meeting, June 8-10, 1949

Control Surveys Division

EDITOR'S NOTE.—At the Ninth Annual Meeting of the American Congress on Surveying and Mapping, the Technical Division on Control Surveys met on June 9, 1949. Capt. H. W. Hemple, U. S. Coast and Geodetic Survey, Chairman of the Division, presided. The session was devoted principally to discussions on highway surveys. The Committee on Highway Surveys reported on proposed Standards, which were adopted by the full Division, and subsequently by the Board of Direction.

Foreword

In studying the proposed Standards, one cannot be other than impressed with the possibilities of providing a large amount of accurate data resulting from highway surveys adequately accomplished, which would be of value to the National Military Establishment for national defense purposes; and of considerable use to photogrammetrists, topographers, and geodesists in furthering the mapping of the country.

The Standards constitute a preliminary report. It is hoped they may be studied by highway engineers, and actually used in highway surveys. The Committee on Highway Surveys will welcome any comments or statements concerning them.

The proposed Standards are given here, together with a transcript of the ensuing discussion.

H. W. HEMPLE,
Chairman

Proposed Standards for Highway Surveys

These Standards apply to ground surveys: (1) for preliminary location of the highway and design of the highway roadway and structures, (2) for location staking of the highway for construction, (3) for the determination of quantities in the contract schedule for final payment to the construction contractor, (4) for "as-constructed" record, (5) for highway maintenance, and (6) for highway betterment and reconstruction.

Surveys are an indispensable part of the operations involved in providing highway service. The cost of ground surveys is a small percentage of the total cost of a modern highway but the annual expenditure for surveys is a considerable sum. With careful planning of operations and use of reasonable accuracy in field practices and adjustment of results, a valuable permanent record may be preserved. The survey may then be used in future highway planning and it establishes a reliable base for all other supplemental surveys for engineering projects in the area served by the highway. Without this careful planning, accuracy and final recording, there is little of permanent value to show for the survey expenditure and practically all the work must be done again when new improvements are necessary. It is the objective in outlining these proposed Standards for ground surveys for highways that all these surveys will serve beyond their initial purpose and become a continually increasing asset.

Low-type roads of primitive or temporary character do not require surveys of high degree of accuracy. Some reconnaissance surveys may be superseded by other surveys or entirely abandoned. Records of these surveys have value but the standards herein prescribed are not necessarily applicable to surveys for highways of this low type. Where economically practicable these standards may be made to apply and the survey will then have permanent value. Surveys for expensive expressways and urban projects must be made with a higher degree of accuracy than is required for low-type rural land service roads. It becomes apparent that standards for highway surveys must be established according to the classification of the highway. The classification of highways as recognized by Federal and State authorities may be used as a guide in the establishment of ground survey accuracies. Ground surveys for highways of similar classification should be made to the accuracy standard applicable. The prescribed standards of ground survey accuracy are minimum and higher degrees are always desirable if economically practicable. In conformity with the foregoing, highways must first be classified for proper establishment of ground survey standards.

CLASSIFICATION OF HIGHWAYS

1. All highways of sufficient importance to justify expressway or four or more lanes as the type of construction and highways on the Federal-aid system in urban areas.

2. Other highways on the National System of Interstate Highways outside of urban areas.

3. Other highways on the Federal-aid system.

4. Highways on the State system of Principal Secondary or Feeder Roads.

For highways in classification number 1, the minimum standard for accuracy for ground surveys shall be "modified second order." For highways in classification number 2, the minimum standard of accuracy shall be "modified third order," but where economically practicable or where the importance of the highway justifies high-type construction the minimum standard shall be "modified second order." For highways in classification number 3 the surveys shall be of at least "modified third-order" accuracy. For highways in classification number 4, "modified third-order" accuracy should be attained if economically practicable. For bridges, tunnels of large magnitude and other structures of large size "first-order" accuracy of ground surveys should be attained; and when and wherever practicable such survey work should be accomplished after consultation, or in cooperation, with the United States Coast and Geodetic Survey. Minimum requirements for first-order work are that length and loop closures shall not exceed 1 part in 25,000.

BOARD OF SURVEYS AND MAPS STANDARDS

On May 9, 1933, the Board of Surveys and Maps of the Federal Government approved specifications for horizontal and vertical control. These have been universally recognized as standards. They are applicable to control surveys to determine the latitude, longitude, and elevation of marked points distributed throughout the area to be mapped. These specifications require a higher degree of accuracy than is economically reasonable as a minimum requirement for highway surveys. They have been used as a guide in the development of these standards so the essential requirements of the Board of Survey's specifications for traverse are here set forth.

It is prescribed that "Traverse of all grades of accuracy shall be run in loops or connected at each end to triangulation or traverse of the same grade as that which is being executed or of a higher grade. No traverse lines that are not thus connected or checked should be used for map control."

It is prescribed that for second-order triangulation or traverse, closures in length or position should not exceed 1 part in 10,000; for third-order work this figure is 1 part in 5,000. This is a requirement that, in taping on second-order traverse surveys, the error per 100-foot tape length should not exceed 0.01 foot and in third-order traverse surveys 0.02 foot. These tolerances seem reasonable for ground surveys for highways as classified above and are adopted in these standards as minimum requirements of accuracy for horizontal distances.

The Board of Surveys and Maps specifications for average triangle closures for second- and third-order triangulation are 3 seconds and 6 seconds, respectively. This requirement is intended to apply to triangulation but if this same angle accuracy were applied to traverse the special equipment needed and the costs would be excessive. It seems logical that the standards may allow the same degree of tolerance for angular accuracy that are reasonable for measurement of length; that is, 0.01 foot and 0.02 foot per 100-foot tape length for second- and third-order, respectively. This will allow a maximum error in a directional sense of 20 seconds for second-order traverse and 40 seconds for third-order traverse, per mile.

STANDARDS FOR HIGHWAY SURVEYS

For these standards it is therefore specified:

"Modified second-order" accuracy shall mean:

The closure in position of a main line traverse, due to length measurements alone, shall not exceed 0.01 foot multiplied by the number of 100-foot tape lengths and the error in angle measurements shall not exceed 20 seconds, per mile.

"Modified third-order" accuracy shall mean:

The closure in position of a main line traverse, due to length measurements alone, shall not exceed 0.02 foot multiplied by the number of 100-foot tape lengths, and the error in angle measurements shall not exceed 40 seconds per mile.

In meeting the accuracy of the angle specifications it will be necessary to repeat the measurement at least twice with a 1-minute transit, estimating and recording the vernier readings to the nearest half minute. For second-order work the number of repetitions required may be four. It is emphasized again that these are minimum requirements. More than usual carefulness must be exercised to insure the desired results.

These STANDARDS FOR HIGHWAY SURVEYS are slightly lower in requirements for accuracy than those of the Board of Surveys and Maps, so the designation "Modified" has been used to clearly indicate this condition.

The Board of Surveys and Maps prescribed the following specifications for leveling, which are recommended as standards for highway surveys:

Second-order leveling—Lines may be run in one direction between bench marks previously established by first-order leveling and the second-order check shall be within limits of 0.035 foot $\sqrt{\text{Length of section in miles.}}$

Third-order leveling—Should not be extended more than 30 miles from lines of first or second order. Lines may be single run but always be loops or circuits closed upon lines of equal or higher order. Closing checks are not to exceed 0.05 foot $\sqrt{\text{Miles in circuit.}}$

These survey standards apply to the transit-traverse and bench mark levels. The line of transit-traverse consists of a continuous series of straight courses and connecting curves or transitions, the length being measured with a steel tape and the angles between lines measured with a transit. Measurements supplemental to the transit-traverse should be made with accuracy in keeping with their importance in development of the standard required. Survey monuments and bench marks must be located and constructed so as to be permanent in character, and shall be established at loca-

tions where they will be most useful during the construction period and for reference in planning future surveys and improvements in the area served by the highway. Monuments selected for permanent markers shall be perpetuated by firmly setting a noncorrodible metal plug in bed rock, a large boulder, concrete post, or on a permanent building. These monuments preferably should be at locations where the site may be occupied by a transit and they should be intervisible. Selected right-of-way markers, specially constructed to insure permanence, make good monuments. For accurate fixing of a center-line tangent, a survey monument may be set at the intersection of the projected tangent with the right-of-way line. At all survey monuments, one or more reference points should be set at points where they will not be subject to disturbance.

Ground survey accuracy standards are of no value unless they are complied with fully. The over-all accuracy of a traverse can be computed if it is tied in at both ends to stations with known adjusted coordinates. Where available within reasonable economic range, monuments set by geodetic surveys near the survey should be tied in and used to check the accuracy of the highway survey. Standard State Plane Coordinates shall be used, whenever possible.

Maximum care, consistent with reasonable cost, will be employed in all survey operations. All transits, levels, and other instruments must be maintained in precise adjustment and all tapes, rods, thermometers, plumb levels, etc., must be kept in good serviceable condition. Suitable entries shall be made in the field notes to indicate that all these instruments and tools are in conditions to provide accurate results. A complete concise record shall be kept of all survey procedures and other circumstances which may have weight in judging the accuracy of the survey.

Repeated measurements carefully noted and adjusted will result in a high degree of accuracy. On the preliminary survey for highway location it cannot be expected that time and effort will be expended to insure third-order accuracy. During the location survey, when the highway is staked for construction, the preliminary survey measurements are correlated with the location survey measurements and differences and modifications in the measurements must be recorded. Measurements made on surveys during construction of the highway and for measurement of final pay quantities serve as additional checks when conditions are usually favorable for making accurate measurements. With all these checks carefully recorded for each survey, including the circumstances prevailing at the time each measurement is made such as weather conditions, condition of engineering instruments and tools, pull on the tape, etc., the degree of accuracy may be increased by mathematical correlation and adjustment of the complete survey record. The final accuracy attained should then be defined in accordance with these specifications; the angles and the distances recorded on the "as-constructed" plans for future use.

DISCUSSION

CHAIRMAN HEMPLE: I ask that Mr. J. C. Carpenter (Public Roads Administration) report on the work of the Committee on Highway Surveys of which he is Chairman.

MR. CARPENTER: Mr. Chairman and Members of the Division on Control Surveys: When Captain Hemple asked me to serve as Chairman of the Committee on Highway Surveys under the Control Division I readily accepted this assignment as an opportunity to develop interest in better surveys among highway engineers. The principal activity of the committee during the past year has been the formulation of Standards for highway surveys. The Standards evolved have been mimeographed and distributed to the members in attendance. We propose to offer them for adoption by this Division and finally by the Con-

gress. We suggest that they be presented to the Association of State Highway Officials and the Public Roads Administration before adoption by the Congress. In obtaining the concurrence of these two organizations we will have covered a large part of the field of highway engineering activity.

In selecting a Highway Committee to function under the Division of Control Surveys we asked representative highway engineers from all parts of the United States to serve. Necessarily the major part of the work has been accomplished through correspondence. Of the Committee we have with us today Mr. Houdlette of Massachusetts, Mr. Greengard of Cook County, Ill., and Mr. Pryor of the Washington office of the Public Roads Administration. Not present are Mr. Browning, North Carolina Highway Department; Mr. Lee, Maryland Highway Department; Mr. Beazley, Florida Highway Department; Mr. Morrison, Public Roads Administration, Utah; and Mr. Grumm of the California Highway Department. My appreciation of the good work done by the members of the committee is here recorded. I hope we will make much more progress next year than we have during the past year.

The Standards are in your hands and I am reluctant to take up the time of the meeting to read the entire text. What do you suggest, Captain?

CHAIRMAN HEMPLE: Could you give a digest of what you have in each paragraph?

MR. CARPENTER: The first paragraph covers the application of the Standards. They are intended to cover everything above the preliminary reconnaissance or tentative preliminary surveys which usually have no particular value for record purposes.

We realize that highway engineers will be reluctant to spend very much more for surveys than they are now spending. Their principal objective is to get the construction work under way, get the traffic over the roads and spend the money they have assigned to them to provide facilities for highway transportation. We do know that there is a considerable sum of money spent each year for highway surveys, and if we can, in some way, firm up that expenditure so that we have a result that is permanent in value, we will have achieved our objective. This axiomatic condition is set forth in the second paragraph.

In the third paragraph, we indicate that we do not intend these specifications to apply to low type roads. But if anybody wants to use them for that, that is fine. Expressways require the highest type of highway survey. Considering these requirements for quality of surveys, we arrived at the necessity for a classification of the surveys in relation to the classification of the highway type for which the surveys are to be made. The classification is set forth in the fourth paragraph. We placed the expensive expressways and all the four-lane highways in the first class. In the second class we included other highways on the National System of Interstate Highways outside of urban areas; in the third class other highways on the federal-aid system; and in the fourth class, highways on the state system of principal, secondary, or feeder roads. For highways in the first class we recommended (paragraph 5) that "modified second-order" accuracy be adopted as standard for the surveys, and for lower types we recommend that at least "modified third-order" accuracy be required.

In selecting these limiting accuracies you will note from the paragraphs following that we attempted to comply reasonably with the standards of the Federal Board of Surveys and Maps. Their standards are set up for geodetic surveys, and we know that highway engineers will not use triangulation or first-order accuracy on any of the surveys, except possibly for very large expensive structures or for urban work. We hope we will be able to do what Mr. Wilson, Chairman of the Technical Standards Committee suggests; that is, prepare a modified set of standards which will be usable by all engineers. We followed the standards of the Board of Surveys and Maps for traverse as closely as seemed reasonable. In so doing we specified that, for second order the accuracy will be 1 in 10,000. That boils down to one hundredth of a foot in 100 feet of linear measure. Third-order accuracy for linear measurement will be 1 in 5,000. We feel that this standard is not now obtained on the majority of highway surveys, but believe that with careful planning and with faithful recording of all survey notes, where parties go over the same ground again and again, provided we carefully indicate errors as discovered, we will in the end bring it to the accuracy we have here specified, and probably to a better standard. But to accomplish this objective we must institute an educational campaign to encourage highway engineers to appreciate the value of accuracy, in the first place, and, in the second place, to bring them to realize that, by making a record of what they do they will achieve this accuracy without additional expense, or very little at least.

In setting up the angular specification we ran into a rather serious obstacle. You may notice that the Board of Survey and Maps' specifications are pretty rigid. After considering the Board's standards, we decided we would try to bring the same degree of accuracy to the

angular requirement as we had recommended for the linear measurement, that is, for modified second-order accuracy 1 in 10,000, or approximately one-half foot per mile. We tried to fix the angular requirement so that we will have no more than one-half foot error in angle in each mile of traverse. This means that with one angle in a mile we cannot exceed 20 seconds in error. However, if we have six angles per mile and allow 20 seconds tolerance on each angle and allow them to accumulate, we may have 2 minutes angular error at the end of the mile. After the Standards were formulated they were typed without the words "per mile" as now appears at the end of the ninth paragraph. These two words were added by the Chairman, before mimeographing, to insure a total angular tolerance limitation in a mile length of survey. Comments on this phase of the Standards are particularly desired.

At the suggestion of Mr. Maltby of the U. S. Geological Survey, we used the word "modified" before the classification of accuracy to differentiate these Standards from the Board of Surveys and Maps' standards which are now universally recognized in geodetic work.

For highway levels, we have followed the same wording as that used by the Board of Surveys and Maps. We are quite sure that this accuracy can be attained without great difficulty.

We have attempted to set forth the particular parts of the highway survey field to which the proposed Standards will apply, that is to the transit traverse and the bench mark levels. We know they will not be applicable to the measurements for cross-sections or for routine measurements during construction. They should apply to all important measurements that will become a permanent record of the highway project. Adequate monumentation of important points on the survey is one of the essentials for a complete and satisfactory utilization of the work involved in making a survey.

These Standards will have no value unless they are used. We hope they will not be filed and forgotten. They are intended to be distributed widely to all highway engineers and used. To use them, accuracy must be checked. Ties to established monuments with known coordinates are the most reliable means to be used in checking accuracy. State Plane Coordinates are the best and simplest medium for use in checking accuracy and also for record purposes. We hope that when an affirmative answer is given to the question, "Do you use the American Congress Standards for highway surveys?" the surveys will be found to check out on the accuracy specified in the Standards.

To adequately judge the quality of a survey the notes must show in considerable detail the kind of instruments used and their condition. They should be, of course, always in perfect adjustment. I think that if it becomes standard practice to note the time and circumstances when an instrument is adjusted, there will be more checks on the adjustments and better maintenance of them. We need more records. Ordinarily, highway engineers make surveys and the notes are placed on file. The next party covering the same ground makes another set of notes, but if the errors in the first notes are not considered of sufficient importance the second party may conclude they do not warrant recording, let them go and the first notes remain as the incorrect record. We do not want to give the impression that all highway engineers are careless about surveys. They are not. Highway surveys are made with enough care to provide a good location and establish accurate quantities for payment of construction costs. If all surveys can be made with reasonable care, checked, adjusted and recorded, we will find we may have attained much higher accuracy than we ever dreamed to be possible.

CHAIRMAN HEMPLE: I look on this as a preliminary report of the Committee. We want to give the widest distribution to this report, refer it to the Public Roads Administration, the Association of Highway Officials, and our own Board of Direction for general dissemination through the Society. I hope through that means we will get comments which can be referred to the Committee, and we will get a final set of standards which can be generally used throughout the highway survey procedures.

The report here is open for comment at this time. I think it requires some study. My own opinion would be that you take it with you and study it and then direct any comments to the Committee.

MR. W. T. PRYOR (Public Roads Administration): May I make a suggestion? It applies to standards for highways, as recorded on page 3, which Mr. Carpenter has previously mentioned. That is in the third paragraph where it begins to read: "The closure in position of a main line traverse, due to length measurements alone, shall not exceed 0.01 foot multiplied by the number of 100-foot tape lengths, and the error in angle measurements shall not exceed 20 seconds per mile." I think the latter part of that sentence may read this way and clear up the problem that Mr. Carpenter mentioned: "The error in angle meas-

urements shall not exceed 20 seconds equivalent to one-half foot displacement per mile.'' Then, for the next paragraph, I would change it to read this way: ''—the error in angle measurements shall not exceed 40 seconds per mile equivalent to 1-foot displacement per mile.''

CHAIRMAN HEMPLE: Are there any comments on that?

MR. E. C. HOUDLETTE (Dept. of Public Works, Mass.): I am just speaking for my own division. We are perhaps a little differently situated than many highway groups in that we have two geodetic survey parties in the field at one time, placed in control of any highway survey. I try to get a control point at least every 5 miles along a proposed new construction job. The control is in. We are simply using the highway traverse to check so we don't have to run any back traverses. We don't expect the same degree of accuracy on the highway survey that we do on a control survey.

Personally, I don't like this wording of the deflection. Whether it is 20 seconds per mile or 40 seconds per mile, or whatever it might be, I think it should be so worded that the amount of error per angle in your entire distance should equal a certain amount. For instance, in our work I require that the state highway surveys check within 5 seconds per angle irrespective of length, instead of saying 20 seconds per mile, 40 seconds per mile, or whatever it is. I think it is entirely dependent on the amount of angles there are in the traverse. You may have a 5-mile traverse with 25 angles and one 25-mile traverse with one angle in it.

MR. CARPENTER: Mr. Houdlette wrote me to this effect in his comments on the Standards. We tried to get the same angular tolerance requirement as we had for linear measurement because we think the Board of Surveys and Maps requirement is much higher than we can expect to get in highway surveys, and furthermore, it is not believed to be absolutely necessary for highway surveys. The thing that worried me is that if we say 5 seconds per angle, when most highway engineers use a transit reading to minutes, we will be immediately condemned as impracticable by the engineers we are most desirous of interesting in the use of Standards. They'll say, ''We don't know what 5 seconds is!'' We must so word these Standards that field engineers and particularly highway administrators will not read them and toss them in the waste basket, saying, ''These men are too radical for us. We want to build highways.'' I agree with you, if we can get so many seconds per angle, that is what we are driving at.

MR. HOUDLETTE: I mentioned 5. I don't necessarily mean 5, whatever standard you want to set. I think it would be better to say so many seconds per angle. In geodetic traverses we don't balance our traverses by the number of miles. We balance it by the number of angles there are in the traverse.

MR. L. G. SIMMONS (U. S. Coast and Geodetic Survey): This 20-second business is left, I think, without the per mile. In running a traverse, we adjust the angle before we compute the coordinates. My idea in trying to compromise between what they can do with their equipment and what they should do would be to insure every angle measured within 20 seconds, then tie at the other end and adjust. You couldn't have that effective accumulation of 20 seconds per angle all the way through. If you are not going to adjust, that is a different thing. Then you have to get something on the order of what Mr. Houdlette was talking about, 5 seconds per angle, if you are going to come out with a proper closure position.

MR. CARPENTER: I suggest we leave this question on adjustment for the Committee to work on.

CAPT. K. T. ADAMS (U. S. Coast and Geodetic Survey): I would like to make one remark. As I understand it, the objective is to require no more accuracy in angle measurements than in your length measurements. If that is true, why not forget about the angle measurements and state that the closing error shall be 0.01 or 0.02 times the number of tape lengths, times the number of hundred feet, or times the number of miles. It doesn't matter whether your error is perpendicular to the line of traverse or in the direction of the line of traverse.

MR. CARPENTER: That seems quite reasonable.

MR. R. M. WILSON (U. S. Geological Survey): That is just a statement of accuracy.

CAPT. ADAMS: That is all you are giving here anyhow. In any traverse of given length —a 5-mile traverse, for instance—in one traverse you may have 5 angles to measure and in another you may have 50. You have to measure the 50 with greater accuracy than the 5 to get the required result.

MR. SIMMONS: Not if you adjust the angles.

MR. CARPENTER: Perhaps we should concentrate on adjustment. I think it is Chairman Hemple's idea that everyone interested will carefully review these Standards and offer his suggestions in writing.

MR. WILSON: Mr. Chairman, the discussion is getting close to what we must consider in

the technical standards for control surveys. Apparently the desire of the representatives of highway surveys is to have the Standards as nearly as possible the same or approaching the standards for control surveys. So it looks to me as if we had a lot in common with the two committees in this respect. I have taken note of that and will ask a lot of questions of them at some future date.

CHAIRMAN HEMPLE: I think we could probably get into a long discussion here. As I say, these are tentative specifications and they are proposed for discussion principally. I would entertain a motion, Mr. Carpenter, to accept them as they are and distribute them as preliminary specifications, if you would care to make that motion.

MR. CARPENTER: I move that these specifications be accepted as preliminary and distributed for discussion and then carefully reviewed before final adoption for recommendation to the Board of Direction of the Congress. Does that cover the field?

CHAIRMAN HEMPLE: Yes, I think so.

MR. PRYOR: I second that.

(The question was put to vote and carried unanimously.)

CHAIRMAN HEMPLE: I want to thank you, Mr. Carpenter, Mr. Pryor, and other members of the Committee. This is a very strong Committee. The members of the Committee are actually engaged and are thoroughly familiar with all phases of highway work. I am sure what we will get out of this is going to be something which will be useful and will improve the standards for highways surveys.

That concludes the business meeting.

We have decided this session would be devoted to a discussion of highway surveys.

Our first paper is, "Highway Location Ground Surveys in National Forests and Parks," by Mr. Lloyd J. Morrison, Public Roads Administration of Utah. Mr. Morrison is on a field assignment in Utah and is unable to be present, but Mr. Pryor, of the Public Roads Administration, will read the paper.

MR. PRYOR: Ladies and gentlemen, it is indeed a pleasure to be given the honor of reading Mr. Morrison's paper. I may state that Mr. Morrison and I had the privilege of working together for a number of years on highway location and on highway construction. Of course, needless to say, I commend his work very highly.

* * *

Highway Location Ground Surveys in National Forests and Parks

By LLOYD J. MORRISON

HIGHWAY ENGINEER, PUBLIC ROADS ADMINISTRATION

IN 36 States, Alaska, and Puerto Rico, there are National Forests. In these forests there are about 23,500 miles of forest highways. Engineers of the Public Roads Administration are charged with the responsibility for the location, construction, and maintenance of these highways. About 86 percent of this work is located in the 11 Pacific Coast and Rocky Mountain States and in Alaska. All surveys and preparation of plans, specifications and estimates for forest highways are made by the Public Roads Administration and are submitted to the State Highway Departments and the Forest Service for their concurrence before construction is started. Details of planning and design work are carried out in the Division Offices of the Public Roads Administration.

The Public Roads Administration serves in a similar way as the road construction agency for the National Park Service under an interbureau agreement in the survey and preparation of plans and specifications, construction and improvement of highways and parkways within the national parks and monuments, and, in some cases, park approach roads. Funds authorized for the construction of national park roads and parkways are under the control of the

National Park Service until allotments are made to Public Roads Administration for specific projects. Surveys and preparation of plans and construction are handled in the same manner as for forest highways and, since the parks ordinarily are located in the same general areas as the national forests, the work is similar and difficulties encountered in forest road construction are equally applicable to park road projects.

The forest and park work in the 11 Western States is under the supervision of the Western Headquarters in San Francisco. The location surveys described in this article are for highways in this western area. In each State there is a District Office and District Engineers are responsible for the field administration of all operations and for the technical details connected with these operations.

The actual location of a highway has a profound and lasting effect upon the service it will provide. If it is in the wrong place or the standards of location and design are too low, adequate service will not be provided and development of the area may be adversely affected. Traffic over the highway estimated for the period of the life of the improvement is usually determined by the State and Federal agencies through cooperative studies, and design characteristics are based on these cooperative conclusions. Once the standards are determined the locating engineer must follow the directives of the District Engineer in working out his location.

Because of the fact that most of the national forests and parks are in mountainous country and usually at high altitudes the location of roads is difficult and construction is expensive, requiring much rock blasting. Snowfall is heavy and temperatures extreme in winter so the working season is short. In many cases the roads are links in important state or interstate highways and some forest highways provide the only approach roads to the national parks and their construction to adequate standards is highly desirable. Aesthetic considerations are of first importance in park highways and this feature must always be considered in all operations so it often is an influence which determines the characteristics of the location of the roadway. Scenic features, timbered areas, waterfalls, lakes and ever changing vistas are controls that are always given full weight in routing and detailed alignment of forest highways, as well as of park roads.

Good location practice requires a proper balance of profile gradient against curvature. The combinations will range from the light (long radius) curve on a level or gently sloping plane to the extreme of a minimum radius (sharp) curve on a compensated ruling or maximum gradient. Construction costs always must be given due consideration but never should influence the combination of grades and curvature so as to create a hazard to traffic. This injunction applies as well to the element of cost of right-of-way as to construction cost. Good judgement and wide experience are of utmost importance in so balancing the effect of right-of-way costs, construction costs, operating costs of estimated future traffic, and other important elements of the location, that the final result will best serve the transportation requirements.

All highway locations are established through complete careful study of the entire area. There are two distinct phases involved, the reconnaissance and the field surveys, which may include several preliminary surveys, and also the location survey of the highway center line.

RECONNAISSANCE

As soon as administrative approval is given to finding a route for a highway between designated terminal points, the chief locator or other direct representative of the District Engineer makes a

complete and thorough field study of all routes worthy of consideration between the termini. Before going into the field, the routings are discussed with all Federal, State, local, and private agencies who may have a valid interest in the undertaking. Highway alignment, profile grade line and cross section standards that will control the location and influence the design are given careful consideration, and general limits are set and approved by the District Engineer. All available maps, aerial photographs, reports on geologic and soil conditions, power site withdrawals, reservoir sites, prior legal actions, land boundary descriptions, and any useful information having a bearing on the field surveys are assembled, studied, and correlated before the reconnaissance is undertaken.

In the field reconnaissance studies all possible routes are investigated. Service to traffic is the all important consideration. Where alternates of equal service value must be weighed, other elements such as total construction costs, operation variables, annual maintenance, recreational values, and future improvement possibilities may be determining factors influencing choice of route.

A typical reconnaissance problem is one involving the selection of a location from the lower end of a valley to a control point in a saddle on a steep ridge above the upper end of the valley. One route may strike across the gently sloping lower valley and then make a quick climb with maximum gradients and sharp curvature to the control point in the saddle. An alternate line would leave the valley floor where a longer climb will permit a lower average gradient and allow considerable adjustment of the alignment to take advantage of favorable topography and also permit the use of much easier curvature throughout. Service to intermediate points will probably have a governing influence in the selection of the route, and the final decision may not be accomplished until preliminary surveys are made over both routes. Good topographic maps and aerial photographs are most useful in reconnaissance studies of this character.

Reconnaissance routes selected for preliminary survey are marked with flags at control points on the ground and a reconnaissance report is prepared for use by the District Engineer to obtain concurrence of responsible officials and by the locating engineer as a guide for his operations.

PRELIMINARY SURVEY

Upon approval of the reconnaissance recommendations, the District Engineer authorizes the chief locator to proceed with the survey and issues instructions which define the character of the operations, sets forth standards for highway alignment and profile grade and includes pertinent comments made by other agencies such as the Forest Service or Park Service.

The chief locator and the locating engineer assigned to make the field survey carefully review all available information on the project and make a joint field inspection of the proposed route and all alternates before the survey party is organized. The survey party for usual mountain road location includes the locating engineer, field draftsman, transitman, head and rear chainmen, stakeman, flagman, levelman, rodman, note keeper for cross section party of two Abney levelmen, and two tapemen. Axmen are employed as necessary to insure good progress. The customary engineering equipment is provided. Transits are of light mountain type or heavier. On preliminary work, use of a transit with horizontal circle graduated to minute intervals may be used, although the preferred type is a heavy instrument with full vertical circle and horizontal circle reading to 20 seconds.

Wye levels are standard equipment although dumpy levels are quite commonly used. Each party has at least two 100-

foot steel engineer tapes which are checked for accuracy at standard temperature before use in the field.

Location survey procedure follows the standard instructions issued to Chief of Party for Location Surveys in 1926 as supplemented by subsequent memoranda and by specific orders and authorizations issued by the District Engineer and the chief locator.

FIELD OPERATIONS

Route-line reconnaissance.—The flagged control points established in the reconnaissance are verified and spotted on available maps or aerial photographs. Careful study of the topography on reliable contour maps or by means of stereoscopic examination of aerial photographs sometimes saves time and expensive field work and results in the selection of a location route line that is the best available in the area under study.

In rugged mountain country where grades, curvature, and costs control the position of the highway center line, field "grade contour" lines are run by using an engineer's chain and an Abney level with the arc set for reading vertical angles in percent of grade. The Brunton compass is sufficiently accurate to determine direction and angular changes for these tentative line surveys. With the profile and map made from this route-line work a preliminary survey line is projected on the map to serve as a guide for the preliminary transit line to be staked on the ground in the field.

Where, as in fairly level or open country, the highway location line may be selected without the use of preliminary survey lines, the transit line will coincide with the final location as it is staked. In the field notes, it is recorded as the line proposed for adoption as the highway location line. In rough and broken country, or where long supported (or sustained) grades are required, a preliminary survey is necessary and a map projection of the highway alignment is made to determine properly the location of the highway.

Preliminary survey lines.—After careful study of contour maps and aerial photographs, and using the Abney level line as a guide, an angle transit line is staked on the ground as close to the final location as can be determined from available information. The transit line is run so as to keep a profile grade line on it from ½ to 1 percent below the maximum grade. This practice allows leeway for required adjustments on the final location. In this work, all preliminary transit survey and level lines are carefully and accurately run to provide correct data for preliminary control of trial location lines to be projected on a strip topographic map of the route as prepared from the preliminary survey.

Measured lengths along the preliminary survey line are horizontal, breaking chain as found necessary. Hand levels and plumb bobs are used except on very steep slopes where slope chaining, measuring vertical angles with the transit or Abney level, may be more satisfactory. Standard ¾-inch stakes are set at each 100-foot station and at breaks in the ground line. Hubs with tacks are used at all angle points. Measurements are made to the nearest hundredth of a foot using approximately 25 pounds pull. Spring balances are not used except for special purposes not ordinarily encountered in either the preliminary survey or the location survey to follow.

Angles are measured either as deflection angles and doubled or tripled, or carried as azimuth using in each case a true meridian determined from a Polaris or solar observation. Courses are checked by compass readings and by new observations at maximum 12-mile intervals. Bureau of Land Management section corners, Coast and Geodetic Survey monuments, and U. S. Geological Survey control points are also used to check direction and distances and where State Standard Plane Coordinate monuments

are available they can be used as latitudes and departures to determine closure errors for the survey traverse. The Plane Coordinate grid is used for field and office plotting of the preliminary survey line and when all surveys have been completed and adjusted the coordinates of monuments tied in or established may be computed and filed as a permanent record. Where existing triangulation points are visible from angle points on the survey they are "cut in" and satisfactory accuracy attained if no angles in the "cut in" triangles are less than 15° and triangle sides are more than 500 feet in length when distances to the triangulation point are long. Secondary points, off the survey line, are sometimes necessary and in all cases the angles involved in the triangulation are repeated at least 10 times with the transit telescope normal, and 10 times with telescope reversed.

Adjustment of the level is checked when the survey is started and during the survey, as required. Bench marks established by the Coast and Geodetic Survey and U. S. Geological Survey are used where available, and railway or even aneroid datum may be used, if no other datum is available. Bench marks are established along the survey line at approximately 1,000-foot intervals. Levels are checked in all cases by running a double set of turning points by the level party or by a "fly-line" of bench levels by either party. Rod readings on turning points and bench marks are read to the thousandth of a foot, using a target, and the rod is plumbed for the readings by level bubble or by oscillation. Levels are checked between preliminary survey and location survey runs, and on established bench marks. If the error in feet exceeds 0.05 miles of preliminary miles of location, the line is re-run and the error finally reduced to this limit. Level rod readings are taken at every station stake on the survey line, at all breaks in profile slopes, and at connecting roads and along flow lines of streams.

Cross sections.—Across each station on the survey line and intermediate breaks in profile slope, elevations are taken at points of change of slope at measured distances out from the survey line so that a cross section may be plotted. The cross sections are taken at right angles to tangents (straight lines) and on radii lines of curves. Readings are taken for a sufficient distance on both sides of the line to permit minor changes in alignment and to insure that cut and fill slopes will catch within the surveyed area. Where large volumes of excavation is involved, the use of a transit to line the section and take the rod readings is sometimes justified, but ordinarily the hand level, Abney level, or Rhodes are with a metallic tape for horizontal measurements and a light 10-foot rod for elevation measurements are standard equipment. Only where topography and ground cover permit rapid work are the sections taken with a wye level. In lieu of cross sections, the locating engineer may take contours using topographers' and office plotting or planetable equipment. Where the line crosses streams requiring major structures, topographic surveys are made covering a sufficient distance up and down stream to insure adequate information for location and design of the structure. At highway or railway crossings the field surveys are made with sufficient accuracy to insure the development of proper alignment and grade.

Working plans.—Where preliminary surveys are used in the location procedure, the field draftsman plots each day's alignment, profile, and cross sections or topography notes and prepares a topographic map, for the use of the locating engineer. For this work, all survey lines are plotted by coordinates to a scale of 100 feet to 1 inch. Sufficient topography is shown on this map to allow

the projection of alignment for the highway location. A preliminary profile is also plotted on a horizontal scale of 400 feet to 1 inch and a scale of 20 feet or 40 feet to 1 inch vertically. This profile is made each day as the work progresses so the locator can be sure he is within the established grade requirement. Cross sections are also plotted.

In addition to the 100-foot to 1 inch scale topographic map a control map to a scale of 1,000 feet to 1 inch is prepared. This map is plotted as soon as the coordinates have been computed and is used as a guide in laying out sections of the 100-foot to 1 inch map. On this map all preliminary survey and location survey lines are finally plotted, and in addition, the rivers, lakes, creeks, land lines, triangulation and traverse stations, railways, power lines, pipe lines, highways and, in fact, all features that have a bearing on the location under consideration are shown on this map.

LOCATION SURVEY

National Forest and Park highway location surveys are made on a basis of highway center lines staked in the field before the party leaves, unless circumstances warrant a modification of this standard method. By center line is meant the highway alignment, not a line to remain absolutely unchanged, but one which will be fixed within such narrow limits as to insure construction within an ordinary width of right-of-way. This located center line for the highway will be one on which construction quantities of excavation and embankment may be balanced as closely as the nature of the country permits and will be selected after careful study by the locator with the plan and profile of the preliminary survey in hand. The center line for the highway will be a well-studied line laid down in accordance with standard transit-line procedure and completely staked, including circular curves, spiral transition curves, and joining tangents.

The final location may be established and staked the same season the preliminary survey is made or it may be staked the following season or just prior to starting construction of the highway. Usually short seasons permit only preliminary surveys the first year; then upon completion of the season's field work all the preliminary survey notes are taken into the District Office where they are thoroughly checked, plotted, and submitted to the District Engineer with a complete survey report. The best possible location line is then determined and staked on the ground later, preparatory to highway construction.

Upon completion of the construction of a National Forest or Park Highway the survey is perpetuated for future use, not only for the Public Roads Administration but for other organizations, public and private, and for individuals. Horizontal control is secured by placing sufficient markers so that alignment and right-of-way can be retraced at any time. Line markers, of galvanized pipe 3 feet long, are set in concrete at the ends of the project and at such intermediate points as will permit the easy and accurate re-running of the center line. Vertical control is secured by placing a line of permanent bench marks, unless sufficient accepted bench marks already exist. Details covering the establishment of permanent markers and bench marks are given in the general memoranda and instructions issued by the Public Roads Administration to Resident Engineers on Forest and Park Highway construction.

PLANE COORDINATES AND SURVEY ACCURACY

In developing the preliminary survey map, projecting the located line and all operations leading up to the final location, the use of a coordinate grid is a necessity. Where Coast and Geodetic Survey or U. S. Geological Survey controls are available the State Plane Coordinates can be used, and when the lines

have been located, adjusted, and checked the horizontal control points of the location will become a part of the State Standard Plane Coordinate System. The use of these established monuments and the Plane Coordinate System provide a simple reliable scheme for an absolutely accurate determination of the degree of precision resulting from the field operations. With the preliminary traverse checked by numerous cross ties on the final location, numerous rechecks during construction and a final resurvey and adjustment after completion of the project, it seems certain that better than "Modified Third-Order Accuracy" will be attained. The same logic applies to the use of accurate control for leveling and establishment of the permanent bench marks.

CHAIRMAN HEMPLE: Thank you, Mr. Pryor. Are there any questions or discussion?

I was interested in the comments on tying into control and if control isn't available to establish an arbitrary datum. The field parties of the Coast and Geodetic Survey on control surveys have standard instructions, whenever points of the Public Roads Administration or other surveys are available that have not been tied into control, that they shall connect to them.

It has seemed to some of us that highway surveys have other uses than for just construction purposes and locations of highways. The following papers are with that premise in mind. The first paper is, "The Utility of Accurate Highway Surveys From the Standpoint of Geodetic Purposes." The paper was prepared by Mr. L. G. Simmons, of the Coast and Geodetic Survey.

* * *

The Utility of Accurate Highway Surveys From the Standpoint of Geodetic Purposes

By L. G. SIMMONS

CHIEF MATHEMATICIAN, U. S. COAST AND GEODETIC SURVEY

WHEN I first saw the title of my part of the discussion it occurred to me that it might be better reversed; that is, utility of geodetic control surveys for highway survey purposes. But after second thought it became apparent that the highway surveys could, if properly conducted, play a part in the geodetic control program of the country, and a very important part.

I presume all of us here are familiar—at least in a general way—with the nature of basic geodetic control surveys. In this country, as in all others, a start must be made from some local astronomic datum which represents the starting point of the surveying and the calculation of geographic positions. As these surveys are extended, and additional astronomic stations are included in the net, there comes a time when consideration must be made of a permanent geodetic datum.

In this country a datum was set for the eastern triangulation and finally after the observations of the transcontinental arc had been completed and a connection made with the Pacific coast triangulation, which was on its own datum, the United States standard datum was adopted in about 1901. This datum involved the astronomic positions of many triangulation stations throughout the country and was derived through a sort of averaging of the astronomic positions as they related to the geodetic positions. Later on,

with the connection to the Canadian triangulation and through an agreement with Canada and Mexico, the name of the datum was changed to North American. After the general readjustment of the triangulation net, made in the 1920's in order to include the strength of new ares, the name of the datum was changed to North American 1927, and is the present basis of horizontal geodetic control.

The filling-in process of the unsurveyed areas has accelerated considerably since about 1930 until at the present time the gaps in most parts of the country have become relatively small and in certain sections, such as parts of Indiana, Texas, and Mississippi, the final breakdown by area triangulation has been accomplished.

There still are some rather large unsurveyed areas particularly in the western part of the country, but these are being taken care of as rapidly as possible.

Even after the accomplishment of the above program, there still will remain several miles between control stations which might well be filled in by agencies other than Federal. With this thought in mind, it has been the policy of the Coast and Geodetic Survey to provide highway stations spaced about 4 miles along the main thoroughfares when this can be done without undue expense. Each station has its azimuth mark and the set-up is ideal for the control of traverses along the highways, which might be conducted by local organizations and particularly by the highway departments, if they can be convinced of the desirability to do so.

HIGHWAY SURVEYS

Since the advent of the State Plane Coordinate Systems all local surveys may be handled on a plane surveying basis and, at the same time, be made a part of the geodetic control net. Mr. Carpenter and Mr. Pryor, of the Public Roads Administration, for a long time have urged the highway people to step up the accuracy of their surveys, for newly located highways or for the re-routing of old highways, and permanently mark the traverse stations.

In order that these highway surveys may serve a real function as part of the geodetic net, it is imperative that they be conducted in a uniform manner and that the recording of the data and the computation of the coordinates be done carefully and systematically. Also of great importance is the recording of the closing errors of the traverses, including errors of position and azimuth, in order that at some future time an adjustment may be applied to the traverse net resulting from the many highway surveys.

At this time I think it well to interject a cautionary note on the adjustment of control data. It is my firm belief that too little attention has been given to the overall picture of adjustment by local surveyors. This came to me forcibly during the old CWA and WPA days when thousands of miles of second- and third-order traverses were run through many states. It seemed to be the common practice to adjust individually what was considered to be the main traverses between Coast and Geodetic Survey control stations. These adjustments would give good results in many cases and then further adjustments were made to cross traverses, tying to previously adjusted work. This first breakdown would many times still give satisfactory results, but as this method of successive adjustments progressed it would become apparent that the final traverses to be fitted in simply would not fit. The steady accumulation of errors finally affected the last lines to be adjusted to the extent that their accumulation would require corrections to lengths and azimuths far greater than the field work justified. A simultaneous adjustment, or one based on simple weighted mean positions of junctions, is not a difficult process and brings about the best consistency of results.

Even in the highest grade work; namely, first-order triangulation, this sort of thing will develop, particularly when the areas enclosed by adjusted work are long in one direction as compared with the other. If we did not watch this continually, the Coast and Geodetic Survey would constantly be in hot water in attempting to keep the corrections of adjusted work down to reasonable figures. This sort of problem applies to all types of survey work; triangulation, traverse, or leveling. If the plan of adjustment is not well thought out from the beginning and carried through to the end, the only method of correcting the work in a proper manner is to readjust and this is a good way to destroy the confidence of users of control data.

Most highway engineers, I imagine, feel that surveying is a necessary evil, so to speak, and that after the completion of the highway the results of the surveys, including their marking on the ground, are not of much importance. It will take some time to change this attitude, but I believe such a change is inevitable with the increase in value of private land and in the growing complexities of modern highway constructions.

The final result as I see it would be traverses along all the principal highways and many of the secondary roads which have all been adjusted to the North American datum of 1927 through the use of the State Plane Coordinate Systems. This would make available to engineers on many special projects, to the property surveyor, and to the mapmaker thousands of additional well-spaced and conveniently located supplementary control points.

USE OF CONTROL POINTS

There is an unlimited use to which these points could be put. They would provide control for additional highway surveys, highway planning maps, and highway inventory maps. Control would be everywhere accessible for photogrammetric work both in mosaic assembly and in topographic mapping. The property surveyor would finally be in a position to utilize the State Plane Coordinate Systems and to do so in a practical and economical manner. The military people would gain through all types of civilian mapping as well as through additional control for their artillery work. But these are subjects for other discussions.

The whole program could be made another instance in which the by-product of an operation can be just as important —or more important—than the original intent of the operations. Even though the cost of highway surveying were doubled in order to step up its accuracy and preserve it on the ground, certainly it could be justified in the public interest.

CHAIRMAN HEMPLE: Thank you, Mr. Simmons. We will defer discussion on these three papers until we have concluded the presentation. The next paper will be, "Utility of Accurate Highway Surveys for Military Purposes," by Mr. Floyd W. Hough.

* * *

Utility of Accurate Highway Surveys for Military Purposes

By FLOYD W. HOUGH

CHIEF, GEODETIC DIVISION, ARMY MAP SERVICE

I AM SORRY that Mr. McCall was not able to write this paper because he is especially qualified for it, having been the Engineer Survey Officer for the Seventh Army for a long time, and inasmuch as it is connected with the military use.

Mr. Simmons just mentioned the fact that control surveys are of great value to the military. I think that is an extremely important use and should be borne in mind by people who are making surveys throughout the country for other purposes.

Until recent years, at least, there has existed a tendency on the part of engineers to carry on special purpose surveys adequate to their immediate needs for the project in hand. These surveys have often been quite extensive in nature where a considerable expenditure has been involved. They have consisted of levels and traverse, often of third- and even of second-order accuracy, and may have included triangulation. It is not unusual for such special purpose surveys to have been carried for many miles through country where no surveys of any sort existed in contiguous areas. One such survey may have represented the expenditure of thousands of dollars and, properly marked with permanent or semi-permanent monuments on the ground, would have served the purpose of private, county, state, or Federal engineers for years to come. However, since the requirements for the special purpose survey were limited to a few months, no thought was given to the economics of preserving such a survey for the future needs of others. I have known personally of instances where relatively long lines of levels were repeated over the same ground twice since the original line, simply because the earlier surveyors, for their own purposes, required no marks other than temporary hubs. Had the first engineer or levelman given any thought to the principles of economies and of national wealth, he would have felt obligated to leave a permanent mark of some type every 2 or 3 miles, at a possible increase in cost to him of as much as 5 percent. The same lack of foresight has obtained too frequently in other types of field surveys.

PERMANENT MARKS

There may be a brief for the private surveyor who thus violates a principle of economics, but such narrow-mindedness on the part of an engineer who is expending taxpayers' money is inexcusable. It matters not whether the taxpayer be municipal, county, state, or Federal. As a matter of fact in these days he probably is all four anyway. Thus he will surely be invited to contribute to the second survey which need never have been run if any reasonable effort had been made to preserve the first one. It is incumbent on the Federal engineer or surveyor who expends taxes collected from the citizens at large to leave on the ground sufficient permanently-marked points so that in the years to come a similar survey will not have to be duplicated for another purpose at the same taxpayer's expense. We at the Army Map Service have considered it good economy to permanently mark all third- and second-order lines of levels and traverse in remote areas where no similar or higher-order surveys

exist. I believe that this procedure is now practiced by nearly all Federal survey organizations.

PERMANENT RECORDS

It is not sufficient to mark adequately such surveys on the ground; in order to be of value to the general public, such marks should be properly described, preferably to permit photo identification, so that recovery is possible. A record of the descriptions should be forwarded to some central agency to which the public has access. Excellent instruments, light to handle, precise, and easy in operation, are now available so that the attainment of third-order accuracy is no problem for the average surveyor.

Twenty-four of the 48 States have legalized the State Plane Coordinate Systems designed by the Coast and Geodetic Survey. Every effort should be made to tie local field surveys into this Federal system. There is a misconception among many engineers that the use of the State Coordinate Systems is limited to surveys of second-order accuracy. This arises from the fact that state enabling acts restrict the legal plane coordinates to those within one-half mile from a second-order control station. This provision applies only to court recognition of their use in deeds and legal records. Surveys of third-order accuracy may be carried any desired distance from the Federal net and there is no prohibition against the employment of State Plane Coordinates in the computation of highway or construction surveys simply because they may be of lower than second-order accuracy. Wherever any type of plane coordinates is to be used, the State Plane Coordinate Systems represent the ideal. They are used in exactly the same manner as any assumed plane coordinates and their application is fully as simple in practice. They have the very great advantage, however, that they are anchored to the national network of triangulation which bears a fixed relationship to the unchanging latitude and longitude intersections on the earth's surface. Stations which are lost can be easily replaced in their exact original position if the survey has been tied to and computed on the State Systems.

MILITARY GRID

The Department of the Army, some 2 years ago, adopted the Universal Transverse Mercator as its new military grid to replace the old non-conformal Polyconic in use since the First World War. The new grid is conformal in that angles are true and the scale is equal in all directions from a given point. It is similar to the Transverse Mercator of the State Systems, except that the zones are much wider and the accuracy without the application of scale corrections is only about one-fourth that of the State grids. It is entirely adequate for military but not for cadastral purposes. There is no conflict between the State and the military grids as they are both conformal. At the Army Map Service, we are easily transforming existing survey data on the State Plane Coordinate Systems to the new military grid thru the use of electrical accounting machines. Thus all highway, construction, and other field surveys which are tied to the national network of triangulation and which are of at least third-order accuracy become an immediate military potential of great value in event of national emergency.

The Army Map Service is nearing completion on a project to provide an index of the horizontal control of all organizations. Some 600,000 stations in the United States are being mass-computed to the new military grid by punch-card machines. The stations will be indexed by 15-minute quads and by ascending latitude within each quad. Each station will carry a symbol to indicate the organization by which it was

established. No such single index of all horizontal control has heretofore been available. Federal, state, county, municipal, and other survey organizations, and particularly State Highway Departments are urged to cooperate with the Department of the Army by tying their field surveys to the national network and by continuing to forward their coordinates and descriptions to the Army Map Service. Cooperation to date has been excellent.

MILITARY PREPAREDNESS

Field surveys should hold a moral and economic obligation among State engineers and particularly among those engaged in highway surveys, since the latter are often extensive in character and usually lie in virgin areas. Many Highway Departments already recognize this policy. These characteristics of the highway survey make them of particular interest to the personnel responsible for military preparedness. Highways constitute important lines of communication. It is precisely here that major engagements develop during a military campaign among ground forces. It is especially desirable that properly coordinated survey control exist along these lines of communication in order that it may be utilized for military purposes should we have to repel an enemy invasion. When the military need arises, duplication of the survey may not be possible. Beside the major requirements of artillery, destruction of roads, bridges, and water supply call for the use of horizontal and vertical control in their reconstruction. Where center line and grade are run in highway surveys with an accuracy inferior to third order or where such survey lines of adequate accuracy are not permanently marked and described, an important military potential is lost. The density of horizontal and vertical control in the United States is far short of that which should be available if we are ever so unfortunate as to face an enemy ground invasion on our own soil.

Indirect fire by artillery has come to demand more and more density of control. The need for such accurate survey control was convincing at El Alamein, where its availability and extensive use by the artillery are given high credit in the rout of Rommel's army. It became increasingly apparent throughout the war that adequate ground survey control properly coordinated was a "must" in order for the artillery to function at highest efficiency. It is required for indirect fire when ammunition is plentiful; when shortages occur, adequate ground control may become the deciding factor in the conflict. The ability to determine correct azimuth and distance and to place our shells in the right spot at the right time may easily spell the difference between a successful advance of our infantry and disaster.

In the European countries, a density as high as 22 horizontal control points for each 1:25,000 sheet is a recognized minimum of control, or roughly 1 point to each 2 square miles. On many sheets in Central Europe, there are four or five times this number. In the United States, the average density of horizontal control does not exceed 1 point for each 7 square miles and in the western half of the country it is doubtful if density of horizontal control suitable and available for military purposes is one-third of this national average. There are huge areas where such control surveys adequate for artillery and mapping use do not exist for hundreds of miles. We have long enjoyed, except for a brief period after Pearl Harbor, the snug assurance that no enemy troops could possibly invade our soil, with the result that we are probably less prepared with adequate ground surveys for mapping and artillery fire control than are most other civilized countries.

This unhappy situation arises from two main causes: first, the complacency

of our legislatures and their reluctance to appropriate sufficient funds for national mapping during the first half of this century and, second, the failure to properly perpetuate many ground surveys which have been paid for and are now lost. In the latter category, we must place highway surveys at the top. Tens of thousands of miles of highway surveys have been run in the United States which are now of no value for military purposes simply because the little extra effort required to insure third-order accuracy and to monument the lines was not undertaken. This procedure should be corrected, but how? In a non-democratic country, the answer is easy. A decree is issued, and such is more or less standard practice in those countries, whereby all surveyors and engineers are required to properly perpetuate their field surveys to make them available for military purposes. The projection and grid are defined; standard procedures and uniform records are maintained. In a Republic such as the United States, no pertinent Federal law would be constitutional as it would be a definite invasion of personal and States' rights. We are thankful that such arbitrary action is not possible here but, in view of this, I would suggest that organizations like the Congress on Surveying and Mapping take positive action in the national interest, both for the peacetime benefit of the general public and as a military preparedness measure, to induce field engineers and surveyors, particularly those engaged in highway work, to maintain at least third-order accuracy in triangulation, traverse, and and level work, to permanently mark their stations at frequent intervals, to describe the stations, and to properly record such information. This is the American way—let us point out to the American engineer and surveyor why good survey control, properly coordinated and perpetuated, is vital to the national interest. We need have no fear but that willing and hearty cooperation will be forthcoming.

CHAIRMAN HEMPLE: Thank you, Mr. Hough. Our third paper on this subject will be by Mr. C. S. Maltby of the U. S. Geological Survey, on "The Utility of Accurate Highway Surveys for Mapping Purposes."

The Utility of Accurate Highway Surveys for Mapping Purposes

By C. S. MALTBY
UNITED STATES GEOLOGICAL SURVEY

I AM AFRAID my paper will be what Mr. Hough referred to as perhaps a rather narrow viewpoint.

Production of topographic maps requires the establishment and use of large numbers of horizontal and vertical control points. The accuracy of the map and its usefulness to the public depend upon the carefulness with which the foundation is established, and these control points are the foundation stones upon which the framework of the map is built. Modern photogrammetric map compilation methods require control planned to fit the photography which is to be used.

Topographic maps are produced in accordance with certain standards of ac-

curacy. The specifications for control surveys, both horizontal and vertical, are well established and in general use by the various Government agencies. Each area being surveyed, whether by ground or by photogrammetric methods, must contain enough control of third-order or better accuracy to serve as the basic framework of the map. This basic or primary control serves to hold the photogrammetric compilation in its correct geodetic position. The compilation, either a planimetric base or a topographic map, is then built up by adjustment of the stereoscopic models in the flight strips to fit these positions.

Field contouring of a planimetric base compilation is accomplished by plane-table, using both the basic horizontal control, with the positions established photogrammetrically from it, and the basic vertical control. Photogrammetric compilation of contours, however, requires carefully planned and accurately determined extension of the vertical control. The accuracy required for this supplemental vertical control is dependent upon the chosen contour interval. It is usually specified that these supplemental elevations shall be correct to within one-tenth of the contour interval.

CONTROL FOR MAPPING

Attempts have been made in the past to use highway surveys as an aid in the establishment of the required amount of horizontal and vertical control for topographic mapping. To be so used, highway surveys must be of sufficient accuracy; base line or center line surveys must be started from and tied to triangulation or transit-traverse stations, established by third-order or better methods, for which geodetic or State grid coordinates are available; levels must originate on and be tied to bench marks based on standard mean sea level datum, established by third-order or better methods; and suitable survey records must be available. Very few highway surveys have been made that meet all these conditions. Furthermore, many highway surveys are in disconnected sections which cannot readily be put together into continuous lines. The difficulties encountered in making the necessary ties to basic control points, checking and correlating the records, and tying together disconnected surveys have made the use of such surveys impracticable.

Another disadvantage disclosed in the use of highway surveys has been that points established generally are not permanently marked. Their recovery is often difficult and frequently impossible. There is a well-known engineering joke concerning the use of a boxcar as a control point. One engineer, making a survey in his home town, thought he had a chance to prove that a boxcar might sometimes be a suitable place for a bench mark. A railroad there had been abandoned, and on the track was an old boxcar which he knew had not been moved for 10 or 15 years; so, he used the axle of the boxcar for a bench mark. He was somewhat embarrassed when the track and boxcar—and the bench mark—were removed within a month, owing to a rise in the price of scrap iron during World War I! To be sure, surveys made for highway purposes do not utilize boxcars for bench marks. Indeed, they are marked adequately for their intended use and in some States they are permanently marked at the time of the final survey, after the road has been completed. In other States, however, they may be neither marked for permanence nor recorded so that they can be used again.

Many topographic maps have been produced with the same lack of permanently marked control. Reconnaissance mapping has had little control to start with and usually little more of a permanent nature when it was completed. Even in recent years some maps have been made by "station" methods, where

the planetable serves to expand a very few triangulation stations into graphic control for the map, with elevations determined by vertical angles. This method gives adequate control for the purpose, but usually only stations on the most prominent points are permanently marked. Neither positions nor elevations established by planetable intersection are sufficiently accurate to qualify as third order.

Current transit-traverse instructions for mapping projects specify methods designed to insure third-order accuracy. They also specify density of traverse lines and spacing of positions to be established which will serve the needs of the map maker, either field engineer or photogrammetrist, who is to perform subsequent operations. Transit traverse, or triangulation of equal accuracy and density where the topography is better suited to that method of control, is planned to establish recoverable positions along or near two sides of each quadrangle to be mapped. Along these traverse lines, permanent marks consisting of appropriately stamped tablets are set at 2-mile intervals, with other identifiable objects located and described along the lines between these tablets. Vertical control, also third order or better in accuracy and usually established with a prism level, may follow the same route, in which case the traverse tablets will also be used as bench marks. Where vertical control only is required, the same spacing of bench mark tablets is specified.

Permanent bench marks or traverse stations are described in the field notes. These descriptions are later published in the form of control lists and give directions, distances, and references to enable anyone to find the marks on the ground as well as their geodetic position or elevation, or both. Other points not permanently marked also are shown in these lists, which are referenced and described so as to be usable for a reasonable period, but are not necessarily permanently recoverable.

Supplemental control, as its name implies, is required in addition to the basic control. Each map-making organization establishes or specifies the type and amount of supplemental control that is required for its compilation methods. U. S. Geological Survey supplemental control consists of elevations, fourth-order or better in accuracy, for selected points on the aerial photographs. The function of this supplemental control is to provide sufficient information to enable the photogrammetrist to level each stereoscopic model and to refer it to a sea level datum. If each model were rigidly perfect, elevations for points in each of three corners would serve to establish the level plane for the model, and an elevation in the fourth corner would be useful only as a check. For various reasons, however, some distortions are usually present, the models are not all rigid, and extra control points are needed. Also, the ideal point for controlling the corner of a model may not be available. This ideal point must be in a small area common to two or three other photographs; it must be one which can be identified without question both by the photogrammetrist and by the field engineer, who must find it on the ground and determine its elevation; and its photo-image must have the proper contrast with its surroundings. When the ideal point cannot be selected, two or more others must be chosen in its place and elevations determined for each.

CONTROL COSTS

Control survey costs have increased along with the costs of other mapping operations. Recently, compiled figures for work now in progress or just completed are as follows: The average cost for basic horizontal and vertical control on 7½-minute maps compiled by photogrammetric methods was 20 percent of the total cost of the maps. The required

supplemental control added 13 percent, making the total for control operations one-third of the map cost. Control was even more expensive on the limited number of 15-minute maps for which statistics were available, with basic control 26 percent and supplemental control 18 percent of the total costs. Control has been completed on one 15-minute map using the elevation meter for as much of the supplemental control as excessive rain and resulting muddy roads would permit. Preliminary estimates indicate that basic control will be about 15 percent and the supplemental about 7 percent of the total cost of this map. Better weather conditions and improvements in the design of the elevation meter should reduce the control expenditures even more.

Photogrammetric compilation of maps results in lower total costs where the terrain and the required contour interval permit the use of that method. However, more control is required, resulting in a higher percentage of the total cost. Maps compiled by planetable methods in the field do not require supplemental control, and frequently the primary control costs can be reduced somewhat. Average control costs for planetable mapping in the 7½-minute series are 18 percent; in the 15-minute series, 21 percent.

These percentages show control costs to be higher in the 15-minute series. One reason is that, in general, the 7½-minute series is needed in urban or highly developed sections, where there is already considerable usable control. The 15-minute series is usually more appropriate for rural or remote areas where there may have been few or no previous surveys of any kind that serve for map control.

HIGHWAY SURVEYS

Highway surveys could contribute materially to map making projects and should help to reduce the costs of mapping. Topographic maps, when available, are widely used by highway departments in selecting new routes, investigating drainage, and solving other related problems. In many states, the highway departments directly or indirectly furnish funds for cooperative mapping programs. It should therefore be to their advantage to make available to the map makers all possible data which will assist in the production of better maps at lower cost.

Proposed standards for highway surveys have been presented for consideration by those concerned. These standards are carefully considered modifications of those promulgated by the Federal Board of Surveys and Maps in 1933. Surveys made in accordance with the proposed standards, adequately recorded, tied to geodetic control, and made available to the map maker, could be called —to coin a descriptive term—"highway control."

Highway surveys that meet or exceed third-order standards should not have to be duplicated by other surveys for map control. Such highway surveys would not ordinarily furnish all the control needed on a mapping project, but in many cases they would provide a substantial part of it. In establishing the required additional points, ties would probably be made to the high-survey points, thereby strengthening the adjustment of both surveys.

Since practically all map compilation is based on aerial photographs, control will be most useful in compilation if the control points can readily be identified on the photographs. Current instructions concerning the selection, marking, and description of U. S. Geological Survey control points have been evolved with this use in mind. The utility of highway surveys to the map maker will depend upon how well their survey points can be recognized and located, both on the photographs and on the ground. The highway surveyor can

materially increase the usefulness of his work if these additional factors are considered, even though he cannot be expected to meet fully all such specifications. The following brief summary of the pertinent sections of U. S. Geological Survey instructions may assist anyone seeking to locate existing control stations and may suggest modifications in highway survey procedures which will facilitate the use of highway control in mapping.

SUMMARY OF INSTRUCTIONS

Instructions both for third-order transit-traverse and levels specify that permanent marks shall be set at intervals of approximately 2 miles. These permanent marks consist of bronze tablets inscribed with the establishing agency's name, the year set, stamped identification marks and—usually—the elevation. Tablets may be set in concrete posts, in large boulders, in solid rock, or in permanent masonry structures and should be placed where they are readily accessible, and least subject to disturbance. Furthermore, they should be as close as practicable to photo-identifiable points such as crossroads or road intersections, angles in shorelines or streams, prominent buildings, or other landmarks.

After the tablet has been set, it is stamped with code letters or numbers, or both, to identify that particular mark to anyone reading its description or recovering it in the field. The designation also indicates whether the tablet has been set on a traverse line or a level line and the year in which it was set.

A description of the location of the tablet includes the name of the nearest post office, town, village, or other well-known locality, with distance and direction from it to the mark in miles and tenths. In areas subdivided into sections, this should be followed by the approximate distance and direction from the nearest corner of the section, township, and range in which the mark is located. The description then gives the position of the mark with reference to local permanent objects such as buildings, bridges, street and road corners or intersections, streams, and other permanent objects. It includes compass direction and distance from the center of the road, local road names, and route numbers. The nature of the object in which the tablet has been set is given, such as boulder, masonry structure, or concrete post. The height above surrounding ground and above or below the road is stated, and if the tablet is in a post or boulder, dimensions are given. All letters and figures stamped on the tablet are exactly quoted in the description. This description becomes a part of the engineer's record for the surveyed line and is included in the published control list for the area.

On transit-traverse lines several permanent objects, such as road junctions, bridges or culverts, section or civil boundary markers, prominent intersecting fences, buildings, power or telephone line crossings, are located in traversing between the permanent marks. Brief descriptions of these objects are included in the notes so that they also may be plotted on the map to assist the compiler in maintaining accuracy. Under current instructions the levelman determines, marks, and describes at least two recoverable useful elevations between permanent bench marks.

The engineer's notes must be complete for all phases of his work; starting and tie points, methods, instruments, and equipment used must be recorded along with all other pertinent data, including weather conditions and sketches. From this record, the office computations and adjustments of the lines are made and control lists prepared. An important part of the list is the amount and direction of closure shown for each line.

Highway surveys which furnish similar data and are of adequate accuracy

could be used as basic control for topographic mapping. However, the most promising aid to mapping projects would be the use of highway levels for supplemental control. The accuracy of highway elevations will be equivalent, or nearly so, to the third-order control now required as starting points for the supplemental-control engineer. Any road for which highway control is available and which appears in the photography used in map compilation will not require any further surveys to determine elevation of picture points on the road. Elevations for points near the road will be readily determined by running short lines from the nearest highway mark. If the highway surveys are made after the date of the photography, they will still be of great aid, both in correctly locating the road on the compilation and in furnishing starting and tie points for the supplemental-control surveys.

MAP REVISION

Highway surveys could help materially in map revision. The U. S. Geological Survey has issued nearly 6,000 maps and has also published and distributed over 3,000 more produced by other agencies. Some have deficiencies which could be remedied by cultural revision or in some cases by merely revising the road information so that new roads would be correctly shown. On all maps which show the higher types of road by a red overprint, this information is revised prior to each reprinting of the map. Data for these revisions are obtained from the most authentic sources available, usually from highway departments or from their latest maps. Office transfer from one map to another, however, particularly if the two are on different scales, or of different accuracies, presents a problem. Another difficulty is that the highway map does not furnish data concerning the changing in contours which occur when heavy cuts or high fills are necessary. If final surveys of new highways were made available to the map maker, both an accurate location of new routes and the changes in adjacent culture and topography could be incorporated in existing maps, as well as in any new compilations.

Therefore it would seem very much to the advantage of State highway departments to make their surveys meet standardized specifications. Their own subsequent operations would benefit; the location and grades of their new roads could readily be incorporated in the revision of existing maps; and the data would make a substantial contribution to the control required for new maps, and so reduce the cost to the general public.

DISCUSSION

CHAIRMAN HEMPLE: Thank you, Mr. Maltby.

The papers are open for discussion. Are there any comments or questions?

MR. WILSON: Mr. Chairman, if you would let me have a minute or two to reminisce. About 1923, when one of the oldtimers of the U. S. Geological Survey, Mr. Johns, saw the wastefulness of running our surveys over highways where surveys had already been laid down, he got authority from the Chief Topographic Engineer of the Geological Survey to try an experiment on the usefulness of highway surveys. That seemed to be possible in Pennsylvania because they were willing to give us the duplicate copies of their notebooks. The surveys were all well marked. With that cooperation, we did one or two seasons' work recovering as many monuments as needed of the state highway surveys in order to observe azimuths on some of the courses to orient those surveys, and also to tie them to nearby triangulation, thereby making it possible to reduce them to the standard datum.

Some of our sheets in Pennsylvania, made about 1923, were, in fact, partly dependent on the control surveys used in that way. That procedure was argued back and forth over a number of years in the Board of Surveys and Maps. My understanding was, at that time, that what was then the Bureau of Public Roads had only advisory capacity as far as what the

state highway departments did. So that it wasn't possible for the Bureau of Public Roads to say to the state highway departments, "Run your highway surveys according to such-and-such specifications in order that they may be useful for other purposes." They could only advise it. In many instances the state highway department didn't feel justified in spending money for that kind of addition to their highway surveys.

I would like to ask now whether that condition has changed at all. Does the present Public Roads Administration have any stronger hold upon what the state highway departments do, so that they could definitely encourage them to make their surveys adaptable for other uses?

MR. CARPENTER: That condition still exists, Mr. Wilson. Under the Federal Aid Act we are not allowed to pay anything for surveys and plans except when specifically agreed upon between the state highway department and the Public Roads Administration. In the National Forests, we do make our own surveys and let contracts. That is the one instance described in the paper Mr. Pryor just read.

Public Roads Administration has felt that this phase of the work was something that the state highway department should be responsible for. We pay no money on maintenance to state highway departments. The states are required to maintain the highways after we build them. In the forest and park projects, we maintain them 2 years and then they are turned over to the state highway department for maintenance. So our function in the whole highway picture is essentially one of arranging for construction and providing transportation for highway vehicles. That is what we are trying to do. It may be that on that account we haven't encouraged as much accuracy in surveys as we might have if we were responsible, as a government agency, for the maintenance phase of it.

It has also been felt that as far as our surveys for highway projects are concerned, they should be made reasonably accurate to determine the cost of construction and to use as control on a construction activity; but, beyond that part of it, we haven't felt that we could legally insist on anything more.

I feel, though, that highway departments are becoming more and more conscious of the value of surveys. One of the things that was quite carefully discussed in our Committee Meetings this year was how we could persuade the highway engineers that they should make more accurate surveys. We evolved from that this program that Captain Hemple has arranged, wherein we asked the Army Map Service, the Coast and Geodetic Survey and the U. S. Geological Survey to present their opinions of what would be of value to them in making better surveys, feeling thereby, if we could put this down and present it to the state highway engineers and county engineers, that they would realize in so doing they are helping everybody.

We, in Public Roads, feel that our job is, with the money appropriated by Congress, to get the transportation available for vehicles. The Act also provided that the states shall prepare the plans and specifications and we do not participate in that cost except in certain cases. It is not customary for us to do that. We have very little to say about what kind of organization the state uses to make its surveys and plans. We are sympathetic to it. Many of our men are not so indifferent as they appear to be, but our fundamental function is to get the right kind of roads, to get the traffic over the roads as quickly and as safely as we can.

CHAIRMAN HEMPLE: Is there any further discussion?

COMMANDER C. M. THOMAS (Coast and Geodetic Survey): I just want to tell you how glad I am to be here and tell you hello. I am up here from Atlanta, Ga., where I am a liaison officer for the Coast and Geodetic Survey.

I want to tell you of a little instance which happened just before I joined the Survey, about how four of these Geological Survey maps saved a big blunder that was about to be made by the State of Virginia Highway Commission.

That was in 1921, I believe, when I was county engineer of Wythe County, Va. The State Highway Department had decided that the Lakes to Florida Highway that was to be located down through Southwestern Florida should go down through Pulaski County and interseet the Lee Highway at Pulaski City. We, in Wythe County, were on the wrong side of the political fence, because our county generally went Republican. So naturally we didn't have as good a pull with the State Highway Department.

We thought surely they were going to use common sense and good judgment and use one of the old state highways that goes through Wytheville, the Fancy Gap Turnpike. The State Highway Commission decided the road was to go through Pulaski County and was to be built new over Big Walker's Mountain. We thought that was a terrible blunder.

I got four of these U. S. Geological Survey quadrangle sheets that had been made of that area of the Parrisville, Grayson, Hillsville and Powhatan Quadrangle. I pasted them together. From that, I drew a rough tracing, bringing

out the salient features of why the road should be located through Wytheville.

I had a plate made from that tracing by a friend of mine in Norfolk, whom I got acquainted with when I was in the Navy. I had about 150 of those maps made from that plate.

Our representative from the county in the State Legislature was Dr. John D. Graham—I suppose none of you know him, but he was a good politician. Anyway, he took that batch of maps down to the Legislature with him at the meeting of the session in January 1922. They wanted me to go down there and do lobbying. I was just joining the Coast and Geodetic Survey about that time and couldn't make the trip. One of the politicians from Grayson County was going to pay my expenses if I would go down and get the road where they wanted it.

The representative passed out those maps to each member of the Legislature and the State Senate. He gave them just about the same line of argument that I had given him when we had a meeting with the State Highway Commission.

As a result of these four U. S. Geological Survey maps, the State Legislature rescinded the decision of the State Highway Department. That is how we got No. 21, the Lakes to Florida Highway, from Cleveland, Ohio, to Charleston, S. C., and terminating down in Florida. That is the way we got it located where it should be, due to the Geological Survey sheets. I certainly am a booster for them.

CHAIRMAN HEMPLE: Is there any other discussion?

MR. NELSON HALLMARK (U. S. Geological Survey): I am a photogrammetric engineer in the Arlington office of the U. S. Geological Survey. I want to make a comment on what Mr. Maltby just said.

I compile topographic maps with the use of aerial photographs. These accurate highway surveys are certainly an aid to us in the photogrammetric section. I have been doing photogrammetric work now for 7½ years. Many times, especially when I was in the Army, the work I did was with inadequate control. I like to do photogrammetric work, but I also like to tie that work to accurate control. If we had these highway surveys to help us tie that map down, I think that the over-all accuracy of the map would come nearer to reaching the national mapping standards.

CHAIRMAN HEMPLE: Are there any other comments?

MR. WILLIAM H. MEYER, JR. (Eastern Manager, Jack Ammann Photogrammetric Engineers): I would just like to inject a thought here that on some of the recent photographic maps being made for highway departments they are taking advantage of State Coordinate grid systems. They are showing the existing government monuments on the maps in reference to these coordinates. On some of the specifications, the highway departments are beginning to realize that it is to their own advantage for future survey work to have us indicate on those maps permanent control points every mile, with reference to them, and tie them into the coordinates on the map. It is a step, to my mind, in the right direction.

CHAIRMAN HEMPLE: If there are no other comments or anything to be called to the attention of the Division, I declare the meeting adjourned. Thank you all for coming.

(The meeting adjourned at 12 o'clock.)

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Announcing

The Tenth Annual Meeting

JUNE 21, 22, 23, 1950

Shoreham Hotel, Washington, D. C.

Cartography Division

EDITOR'S NOTE.—The session of the Technical Division on Cartography was held at the Ninth Annual Meeting, June 9, 1949, with W. C. Crump, Chairman of the Division, presiding.

CHAIRMAN CRUMP: It is a real pleasure for me to welcome you to this meeting of the Technical Division on Cartography, and I sincerely hope that you will derive some benefits from it.

(Here followed a report on the activities of the Division during the past year, which was published in the July-September issue of SURVEYING AND MAPPING.)

Communications with H. R. Saunders, Sherman Oaks, California, indicate an increase in the interests of the Congress, and the Division on Cartography, by surveying and mapping activities and personnel in the Los Angeles area.

In accordance with Section 8 of the temporary By-Laws under which we are now operating, a Nominating Committee, consisting of O. H. Nelson, chairman, and Messrs. Bay and Stanley, members, was appointed to prepare a ballot to be mailed to the members of the Division previous to the Annual Meeting. Approximately 100 ballots were mailed or distributed to known members of the Division.

A Committee of Tellers was appointed to count the ballots of the election of new officers for the coming year. At this time I will ask Mr. Fuechsel, chairman, to give us the result of the ballots.

MR. CHARLES F. FUECHSEL: Mr. Chairman and members of the Division, 48 ballots were returned, and for chairman, Mr. Warren C. Crump was elected unanimously, and for the three directors to be chosen, Mr. Newman Bumstead, Mr. Robert J. Voskuil, and Mr. L. A. Bloom were the first three, in that order.

MR. CRUMP: Many thanks, Mr. Fuechsel, to you and your Committee for the services rendered in counting the ballots and in making the report.

Thus I have summarized briefly, with the exception of the preparation of details for the Annual Meeting and Panel Discussion, the activities of the Technical Division on Cartography for the past year. Your Executive Committee trusts that you will feel, as they do, that much of the necessary preliminary work in reorganizing the Division is behind us and that their efforts have been worthwhile.

I should like to thank every member of the Board, each officer, and each committee chairman and member, for his loyal attendance at meetings, and for the assistance and support given me during the past year. In addition I wish to thank the officers of the Congress for timely suggestions, advice, and counsel rendered.

The feature item of this session is the panel discussion on "Cartography," with Mr. Newman Bumstead as Moderator.

Mr. Bumstead is Research Cartographer of the National Geographic Society, where he has been employed since 1931. Keeping abreast of the developments in the field of mapping and reproduction, he has contributed several of his own, including a map-name photo-composing machine developed by him and his father, the late Albert H. Bumstead. His present duties include supervision of the preparation of all black and white map illustrations which appear in the National Geographic Magazine. Mr. Bumstead will now take over the program and introduce the panel members.

A Hypothetical Map of North America

(A Panel Discussion)

Foreword

MODERATOR BUMSTEAD: Mr. Crump, members of the American Congress on Surveying and Mapping, gentlemen, and some ladies. The mapmakers and cartographers have distinguished themselves perhaps more than any other professional group I know of by their ostrich-like tendency to keep their heads buried in the sands of time-worn procedures and techniques.

Of course, I think I should say that the ostrich with his head in the ground produces some pretty fine plumage on his other end. By the same token, I must confess that we, with our heads in the ground, have produced some very fine maps, but if we are to progress as a professional group, we must get our heads up and take a general look at the field from one end of cartography to the other.

I have heard some people try to set definite limits to the extent of that science. There is some question as to how far front it begins. Does it begin some time during the field work, or does it begin some time after the field work is finished? Is cartography all over when the finished map is turned over to the printer, or is it all over some time after he has approved the first press sheets?

I don't think this question is very important to us this morning, that is, just where it begins and where it ends. But I do think it is very important to us that we do something that will enable all of us to have a more general understanding of the field at large.

And, more specifically, I think it is important that each one of us in his own little group gets an understanding of the work that goes into the job before it come to him, and of the work, the problems, and the limitations of the procedures that follow his.

We have before you this morning a panel of cartographic experts who are going to make a number of short talks. I have asked them all to keep these talks short. There are going to be five of them, one by each of the five panel members.

These talks are going to be applied to making a hypothetical map of North America, each man stating the problems from his own point of view. Those problems are going to range from the question of the projection through the collection of source material, the compiling of the source material, the turning of that source material into a neat drawing for the printer, and then finishing off with the printing.

After these talks, which will give you an idea of the various branches of the general field, we will receive questions from the floor. We would like to have these questions short and to the point.

To introduce our panel members, the first one, well-known Mr. Wellman Chamberlin of the National Geographic Society, is an expert on projections. His duties at the National Geographic Society entail the selection of a projection for every map the society produces.

After he has selected his projection, he computes it, but he is not through then. He must then plot it, and in addition to those responsibilities, he seems to find a little more time, and spends that whittling, at home of course, and writing books on projections at the office.

After Mr. Chamberlin has produced this projection of the map of North America, Mr. William E. Davies of the Army Map Service is going to tell you how we will collect the source material.

Mr. Davies is assistant chief of the Technical Services Division of the Army

Map Service. His work there entails the supplying of maps of all kinds, aerial photography, and general map intelligence for the Army.

In addition to that, his division is responsible for the Army Map Service Library, which has one of the largest collections of maps in the world.

Mr. Davies has before us all the source material that he thinks we can possibly use. We are probably going to have more than we need. That is usually the case, that these fellows get together more stuff than the next man wants. They are not perhaps as selective as the next man would like to have them, but when he finishes, Mr. John I. Davidson of the Geological Survey will tell us how we will sort this material and from it select the material we want on the map, and how, from that, we will produce what might be called a compilation drawing.

Mr. Davidson is chief of the Trimetrogon Section of the Geological Survey. His work there for the past few years has been in the compilation from aerial surveys of aeronautical charts, the million series with which we are all familiar.

When Mr. Davidson has finished his work, we will be ready to get down to the business of drawing the map. I think it is interesting to see how far we have gone without setting pen to paper, as drawing men would say.

Drafting this compiled map into a neat drawing will be discussed by Mr. Walter S. Dix of the Tennessee Valley Authority. There are probably few men in the business who have had as much experience, as much varied experience, as has Mr. Dix. He is one of the first members of the American Congress on Surveying and Mapping. At the present time he is its Executive Secretary.

When Mr. Dix gets through drawing that map very neatly, we are going to call on Mr. William W. Heintz to tell us how to reproduce it. Mr. Heintz is president of Williams and Heintz Company, Inc., lithographers, of Washington, D. C. His firm produces a good deal of government map work on contract, and many of you have had contact with him. In addition to that, Mr. Heintz is president of the Washington Litho Club.

The next gentleman, Mr. Hanson Hoen of Baltimore, is not going to make a talk. He is going to handle questions during our question period. I think it should be noted that Mr. Hoen wasn't able to stay away from this place this morning. It was physically impossible for him to do so. So I just thought we would have him on the platform with us.

I will now call on Mr. Chamberlin to tell us what projection we are going to use for this hypothetical map of North America.

Projections

By WELLMAN CHAMBERLIN
NATIONAL GEOGRAPHIC SOCIETY, WASH., D. C.

I THINK I won't tell you what projection is used, but what projections we might use. When faced with a projection problem I usually try to think of the coverage of the map in terms of the spherical rectangle which you have to lift out of the globe to lay out flat for your map.

In the case of North America, we find that that rectangle would have to be about 85° in arc in its north-south extent, and about 70° across. If we center the projection, one of the azimuthal projections, somewhere near the geographic center of the continent, we find that we have about 45° to 50° maximum reach.

Now, I am sure you are all familiar with the azimuthal equidistant and the equal area projections. If we use one of those, the equidistant, of course, will give us the true scale from and through the center.

We find that we run to about 11 to 14 percent scale variation—that is all plus —out near the edges of the map. If we

use equidistant, that scale variation would be cut down to 8, or 10½ percent, and there, of course, we run into the increased angular distortion we get with the equal area.

In conformal mapping, just as a contrast, a stereographic projection of the area would have an extreme error of from 17 to 22 percent. I once laid out a transverse Mercator of the continent and found that if I made my scale true about 17° on each side of a great circle running from a point in the Aleutian Islands to Maracaibo, Venezuela, I could include the whole region nicely within a 10-percent error range. It would drop down to about 3½ percent minus through the center of the map.

The American Geographic Society has made a map very similar to that, also conformal, which used the Lambert conformal in oblique position, and the scale there follows very much that same line.

Let me say to all of you, there is no *best* projection. In our work we usually think of the best one as the one that gets the truest over-all picture. We are not making specialized maps, but you can't say that one projection is better than another, any more than you can say a hammer is better than a saw.

The purpose of the map decides the projection, and once you have made the projection, you have pretty well determined the purpose for which the map is to be used.

MODERATOR BUMSTEAD: That is fine. It has often been said that the best speech is the short speech, and I think that was a very good one.

Now that the projection question is settled, Mr. Davies will tell us something about source material for our map.

Source Material

By WILLIAM E. DAVIES

TECHNICAL SERVICES DIVISION, ARMY MAP SERVICE

I AM AFRAID source material is quite nebulous as compared to projection, especially when you consider the tremendous range of information that must go on a map.

The basic thing in the selection of source material is, of course, to try to get it somewhere near the scale of the map, for sheer economics involved in map production necessitates it. Let us look first, though, at the types of information we would consider for a map of North America.

Maps, not only topographic but geologic, soil, mineral resources, every other type imaginable must be considered, because in many parts of North America—really, I ought to say all parts of North America—there is very little topographic data. Canada is practically blank, and much of our United States is blank.

Therefore, we must go to other than just topographic maps. So we consider soil and geology and anything else that resembles portrayal of the earth's surface.

Then we have the problem of other things that have to go on the map, such as road data. There we have to search for road maps or road logs or anything else that will give us the information to fit the classification that is given on the map.

Then we have such things as descriptive information. Books, travelogues, writings by scientists, or anything similar may be necessary when you consider an area such as the central part of Canada and the northern part of Canada where very little true mapping has been done.

Furthermore, you have aerial photographs that must be collected, and then also such minor things, yet so important, as the census reports necessary to classify towns, reports on various boards on geographic names, and so on, in order to arrive at the correct spelling of the towns.

In other words, the source of mapping information is not maps alone but a tremendous amount of allied material,

textual and otherwise, that comes along to fill out the map itself.

The location of this information is just about as varied. You have libraries such as the Library of Congress, the library of the National Geographic Society, the other libraries, both private and governmental, that hold a tremendous amount of mapping material.

Also, you have a large number of libraries, of course, that hold specialized subjects, such as geologic material or census material, and so on. All of those have to be ferreted out and the material gotten from them.

Then you have such sources as the gasoline companies, the various automobile clubs, the highway departments of states and provinces, and so on, all of which must be contacted if you are to get the latest road information.

The private collectors, too, often form an excellent source of material. For instance, Mr. Stefansson, with his large library of Arctic material, would certainly be contacted for any work involving the Arctic, and certainly a North American map will involve the Arctic. There are a number of other private collectors who must be contacted in the material gathering.

Then there is aerial photography. That is a little more difficult to get, because aerial photography is generally flown for commercial purposes, and as such must be protected. But that must be ferreted out, the corporations holding it contacted, and releases obtained.

If that was all there was to it, that would be fine; you could turn over to the compiler a tremendous pile of material wrapped up in a red cord, and say, "It is yours from now on." The only trouble is, you have to do some selection, and your selection and evaluation become a rather complex problem. You must evaluate as to reliability. Is the road shown really there? Is the road classified—actually in the condition it is shown? And you will find that that is quite a problem.

Are the maps suitable for the map being produced? It would be rather foolish to send flock after flock of 1:25,000-scale maps to produce a 1:17,000,000-scale final map. In other words, has the map source actual utility in the map being produced?

Then you have to clear such things as, what is the proper spelling of names? Are they acceptable to everyone? They must be cleared through the proper authorities, either private or governmental, as the case may be.

You also have the problem of discussing and advising the compiler what information is portrayable, and then generally making it a two-way affair, cooperating with him to see that the material is gathered and is in proper form for him to use.

So you see, the source material is not just the case of running down to the library and pulling a map out and handing it to the man and saying, "Here it is, just copy it, it's yours." It is a rather long, complex process, involving a tremendous amount of work to arrive at a few selected sources to be used in the final map.

MODERATOR BUMSTEAD: It sounds very much to me as if Mr. Davies is a typical source material man. That is just about what I am accustomed to hearing from source material people. However, my next man, Mr. Davidson, is used to working with source material people, too, but I am sure he will know just what to do with that material. He, by the way, is going to compile this varied source material into a coherent unit of mapping.

Compilation

By JOHN I. DAVIDSON

THE METROGON SECTION, U. S. GEOLOGICAL SURVEY

I ASSUMED in preparing these brief remarks that I was dealing with compilation from source material and not

any original compilation from field notes or compilation such as a photogrammetric type where you have to begin and construct the map entirely.

Compilation may be rather loosely defined as the combining of assorted pieces of maps and sketches, modified by reports, into a uniform, congruous, legible base, which will serve as copy for color separation drafting. The limits of the operation are not distinct, in the initial stages perhaps overlapping source material collection. The completion of a compilation base may also overlap drafting. One of the important things to consider, I believe, is scale. We have been talking about a map of the North American Continent. That wouldn't be any particular difficulty to a compiler. It could be roughly compared, after the source material is delivered, to a map of the same scale any place else in the world. I think that for compiling, the scale and the use of the map are the more important considerations.

Evaluation of source material is extremely important for small-scale compilation because of the large area involved. Numerous series of maps must be used and often the control is based on different origins. Geographic control should be identified, by description, on maps selected, and plotted by coordinates to evaluate position accuracy. Considerable judgment is required in shifting position when it is discovered that a map series to be used does not agree with control, or that control from differing origins must be used. First-order triangulation on a national or continental datum, such as North American 1927, obviously has the greatest weight, followed by isolated first-order triangulation nets, second- or third-order triangulation, and astronomic stations. Vertical data are, of course, subject to corresponding discrepancies which must be considered, but are not nearly as important in small-scale compilation.

Specifications for the type and amount of detail desired must be established. The selection of details pertinent to small-scale administrative or planning maps is a subject requiring considerable thought. Selection of important detail has been facilitated in recent years by photo-editing compilation material against aerial photographs. In the cases where source maps are basically accurate, up-to-date culture is easily obtained from photographs.

Combining several pieces of information into a compilation base may be handled by one of several methods depending on manpower, equipment, and photographic facilities available. Some of the choices are: Direct tracing, and reduction or enlargement to a common scale with a reflecting projector; photographic copying to a predetermined common scale, or original source maps, or tracings of same, and the mosaicking of film positives or negatives on Dyrite. From this combined copy, blueline, blackline, or sepia prints on a variety of materials may be obtained.

When a permanent compilation base is desired, the most generally accepted board consists of a high-grade, 3-ply, high-polish, enamel-surfaced drafting paper mounted on an aluminum sheet, although metal sprayed with Duco is also accepted. For permanence there is no stick-up on this board. Four colors of ink are used—black, red, olive drab, and green. Symbols and line weights are the same as will be used for the color separation drafting.

Depending on the time available and the type of copy desired, short cuts may be employed at various stages. Small pieces of compilation on white back acetate may be mosaicked at this stage, or from a mosaic of negatives, several boards may be made photographically, each to serve as copy for one color in final drafting.

MODERATOR BUMSTEAD: I always feel that people who know nothing about mapping see in their minds, or imagine, that little goes on except actually drawing the map, but those of us who are in the business know that that is really a very small part of the job. But that small part now is going to be discussed by Mr. Dix. He is going to speak on the preparation of copy for this map of North America.

Drafting

By WALTER S. DIX

MAPS AND SURVEYS DIVISION, TENNESSEE VALLEY AUTHORITY

WE HAVE the map compiled, a "manuscript draft;" a single base delineating map features and basic information by identifying colors of ink, with emphasis on correctness of information rather than ultra-refinement of appearance. I might add that the colors Mr. Davidson mentioned are good photogenic colors, and that is important.

Assume we have instructions and one or two information sheets augmenting the manuscript to clarify and guide subsequent operations in compliance with requirements.

Assume that quantity, quality, and full-color map publication is required, rather than a monotone edition or a very limited number of copies.

Also assume that basic copy is required, capable of processing through either a typical lithographic plant, solely photo-mechanical; or a map specialty plant, which usually combines modern photo-mechanical and old-time lithography, and sometimes also includes one or more of the engraving methods as well.

Therefore we select the procedure of color separation by smooth ink drafting of facsimile non-photo blue compilation image on scale-stable "mounts." We shall assume the mounts are available in adequate supply as required.

A precise and scale stable "master negative" of the base compliation is required—made larger than publication scale to allow subsequent refinement by photo-reduction during final reproduction. This master negative may be a single glass negative, dry plate, or wet plate, or the master negative may be mosaicked from large or small films fitted to the projection etched on a glass base; or for less precise work, upon the projection etched or inked on one of the more stable plastic bases.

If scale and register are not too restrictive, under some conditions, a whole film negative might "get by." By exposure to the master negative, facsimile non-photo blue images are now made upon the drafting mounts which were sensitized with a coating of blueprint solution. A common terminology for this blue image mount is "blue board." A sufficient number of facsimile image blue boards is required to satisfy the basic line delineation color separation, plus as many more to satisfy special symbolization, lettering, color tints, or tint outlines.

If we assume the separation of color at drafting to be the grouping on one drawing of all elements of the map to appear in any one printing, on one press plate, that is, in general, we would need one blue board for each printing plate at press. Should it be required to isolate the map elements separately, either for productive scheduling of more draftsmen in a given period, or for inclusion or omission or color grouping—as desired by subsequent selection at later stages of processing for publication reproduction—then of course we would want one blue board for each of the element isolations. This might mean several boards for each of the final printing plates, as the elements might be combined to form said plates as required. For "tint" boards, or for outlines not too critical to register, some of the more stable plastic sheets may be substituted for the mounts. These may be either transparent, translucent, or opaque; the latter would need

the "blue image," the others can be used to trace directly from another image. (The specialized map plants in all probability would have their individual preference in number of basic separations and basic outline guides.)

It is good policy to preserve the master compilation base negative both for contingency, and for subsequent future map use in making extra blue boards for overprinting map editions for special information, such as populations, transportation, vegetation, etc.

After the image is developed and fixed on the blue boards, a good surface sizing may be applied; then, when dry, the board surface is "smoothed" to the draftsman's taste, and by his preferred method, in preparation for the smooth-draft inking. Highly skilled draftsmen carefully and faithfully ink draft the selected elements from the blue reproduced image of the manuscript, now in facsimile upon each blue board. This selection, or separation, in smooth, sharp, clean, blackline drafting on a mixed white and non-photographic blue background will be the basic color separation copy that will go before the camera for reproduction processing, through to publication. The lettering and marginal data, which may be typeset and printed on opaque or transparent media, or even photographed on film, will be affixed to one of the blue boards, either alone or in combination with a like printing color element, and it will become copy. The copy for the tint plates can be prepared in area outlines or as area solids. It is not a bad idea to check with the reproducer if possible, for preference. In fact, I will say that, whenever it is feasible, it is just good engineering to design procedure and process into requirement and facilities, all the way. Some plants prefer "blue-glass" methods; some like to go to transfer; some like interposition screening; again, others like transfer. Some even try the stick-up style of adhesive transparent base patterns, such as Zip-a-Tone.

Therefore, we will furnish smooth drafted copy of basic line separations, and lettering, on blue boards; and the area outlines on stable plastic transparencies, for tint and color guides. The reproducer can utilize these "guide sheets" to best advantage.

MODERATOR BUMSTEAD: Mr. Heintz will now tell us how we had best print this map. I want you to know that he is not a prejudiced man, but maybe it is remarkable to note that there is some similarity between the suggested method of reproduction and the business he is in. But he will explain that, too.

Reproduction

By WILLIAM W. HEINTZ

PRESIDENT, WILLIAMS AND HEINTZ COMPANY, WASHINGTON, D. C.

THERE ARE only three, and three only, basic methods of putting ink on paper; in other words, of printing. There is relief printing from type, or line cuts, half-tones known as letter-press printing. There is intaglio printing from an etched surface, which is the rotogravure method of printing, and there is printing from a plane surface, which is known as lithography.

Let us consider the requirements of a map and apply it to these three basic methods of printing, and see which of the three we would choose in printing a map. And after we have chosen our method of printing, then we will proceed to explain the various steps that are followed before the map comes out as a finished sheet.

In the first place, no map is ever standard size. There are as many sizes of maps as there are different kinds of maps and scales. So, therefore, we have to have a method of printing which is not restricted as to the sheet size and the number of colors.

This immediately eliminates web printing. Web printing is printing from a roll. In the case of web printing, which is a very rapid means of printing, you have to fit the job to the width of the web of the press. You have to print a full web, or else you waste too much paper. Neither can you change the number of colors on a web press. A web press has four color units. It has to print either four colors or less than four colors.

You cannot run a web back through the press again, because if the paper were to change in running through just one-tenth of one percent in size, by the time you run the sheet back through a thousand inches you would be out of register one inch. So you see, web printing is out of the question, whether it be by offset or by rotogravure.

Another requirement of the map is that it must be printed on a hard surfaced paper, because maps get a lot of use. They have to be folded and unfolded and used, or they have to be hung on the wall, and they take a lot of abuse. Therefore, you cannot use a soft book paper or enamel stock. We must pick a method of printing which will print legibly on hard paper.

A third requirement is that the lines must be sharp and fine. Especially in a very small-scale map like this of North America, you have to have some very small lettering. In order to read small lettering, the lines of the lettering have to be very, very fine or else they will fill up. So, therefore, that again eliminates rotogravure, because by its nature rotogravure is a continuous-tone method, and if you have ever looked at a rotogravure type through a glass, you will see that it is quite fuzzy.

Another requirement of a map is that it must be correctible. All of the procedures that have gone before, as explained by these gentlemen, are very complex and it is very possible that errors have been made along the way. And so, until the job is completely proved up in all its colors, we do not know how correct it is.

We will find a lot of errors on the map in the way of mispelled names, misplaced names, and wrong colors. There never has been, and as far as I know there never will be, a one hundred percent perfect map by the time it gets approved. Therefore, we must have a method of printing in which the plates are readily correctible.

The fifth consideration in preparing a map is the fact that you must have a method of preparing very large plates; that is, an economical method. You can't use a method that will cost a fortune to prepare the plates and then have a slow method of printing.

All of these things add up to only one thing. The only logical method of printing any map is by lithography. You cannot use rotogravure because of the fact that you cannot print off a web and you cannot print fine lines, and the cost of the plates is out of the question.

In the same manner, letter-press printing does not lend itself very well except for very small maps where you can make small-line plates. The cost of a large-line plate is very high. It is a very expensive proposition, and it is practically impossible to correct.

Neither can you print on hard paper by direct printing except with a terrific amount of impression, and to make ready in such a case is prohibitive. Therefore, we assume that the logical method of printing a map is by lithography.

So we now have the blueline boards that are drafted, and prepared by all of these experts down the line, and they are now turned over to the lithographer. The first thing that he does with them is to photograph these boards. They must be photographed on a dimensionally stable base. Up until recent years, the only way that we could possibly make

maps and be sure that they would register was on wet-plate negatives. Dry-plate negatives are not too satisfactory; they are too expensive and the lines are not as sharp. Therefore, we use wet-plate glass negatives.

Recently, there have been developed some new plastic bases that can be photographically sensitized. So we would either make negatives on film or we would make wet-plate negatives.

These negatives as they come from the camera will have all of the imperfections in them that were on the drafting, not through any fault of the draftsman, but through much handling there is bound to be some dirt on the original. And all of these imperfections must be removed.

Also, in the very photographing there will likely be pinholes from dirt in the room or on the copy glass. Therefore, the negatives must be refined by negative engravers and opaquers. The opaquers take a very quick-drying opaque ink and spot out all of the imperfections, pinholes, and dirt. The negative engravers have little needles with which they open up the lettering that was not quite black enough to photograph, and the roads, where the ink dried a little on the draftsman's pen, and so forth. All of these imperfections in the negatives have to be fixed before they may be used.

After that, there is a choice of two methods of preparing plates. I will not get into that because it is too complicated. It depends on whether you use deep-etched, or albumen plates. If you make deep-etched plates, they are made from positives; if you use albumen plates, they are made from the original negatives. The plates are coated with a light-sensitive coating and placed in a vacuum frame. The negatives are placed in position by predetermined register marks and exposed. The plate is developed and is now ready for press.

When the plates have been completed, they are placed on the offset press. The offset press is a rotary machine. It is basically a machine of three rollers—the plate cylinder, the blanket cylinder, and the impression cylinder; the plate cylinder being above the blanket cylinder and the impression cylinder being behind it.

The basic premise of lithography is that grease and water do not mix. After the image is placed on the plate, the plate is impregnated by a greasy image, and then the remainder of the plate is made repellent to grease by means of a plate etch.

The plate itself carries a grain which is placed on by a mechanical graining machine before the plate is made. The press has two sets of rollers. It has a set of ink rollers to keep the plate rolled up in ink, and a set of damper rollers to keep the rest of the plate damp with water, in order to keep the rest of the non-printing areas from taking ink.

As the machine turns over, the impression from the plate is taken on a rubber blanket, and the rubber blanket prints to the paper. That is the reason why it is called offset. You offset from the plate to the blanket to the paper.

Because of the fact that we print from a rubber blanket and not directly from the plate, we are able to print on very hard papers, and we are also able to print very sharp, fine lines without the terrific impression required in letterpress printing.

As the sheets come through the press, they are delivered on the delivery end and run back through the press for each succeeding color. We also have multicolor presses in which we can print two or four colors at the same time, in which case we have one feeder unit connected with two- or four-color units. Because the machine is sheet-fed, we are able to run the sheets back through the required number of times to obtain all the colors.

We have other controls of registering the sheet, so that if the paper does go

out, we are able to correct it and to give a perfectly registered sheet in all the colors required.

MODERATOR BUMSTEAD: That gives us a pretty general understanding of the problems involved in making a map of North America.

I will now invite questions from the floor, but before I do so, I want to urge you to make them brief. I want also again to urge my panel experts to be brief, and if they happen to sit down without thoroughly answering the question, we will ask it again.

Mr. Crump wishes me to announce that the proceedings this morning are going to be published. Therefore, we would like to have you state your name when you ask the question.

Now, may we have a question?

DISCUSSION

MR. CHARLES F. FUECHSEL (U. S. Geological Survey): I would like to ask Mr. Chamberlin for his opinion of the relative merits of the transverse Mercator and polyconic projections for large-scale mapping, 1 inch to the mile and 2 inches to the mile, and so forth.

MR. CHAMBERLIN: The transverse Mercator is conformal, and it has that very definite quality. The polyconic is not. Of course, the polyconic has been modified for the 1: 1,000,000 sheets. Here they have made the scale true along two separating meridians, and they have modified it to make the meridians true. There I think you would find very little difference. The transverse Mercator also has slightly curved meridians.

In scales of that sort I would not feel that it would make very much difference, except that you would lose conformality by taking the polyconic.

MR. FUECHSEL: I would like to ask one more. On the small-scale maps—that is, 1: 1,000,000, 1: 2,000,000, and so forth—is the polyconic usually a modified one?

MR. CHAMBERLIN: I should probably state here that these questions are entirely out of my field. When we make what we call a very large-scale map, it is 1 : 2,500,000. We hardly ever have the problem of large-scale maps; I am sure many of you gentlemen know far more about them than I do. But the polyconic that is used in the 1 : 1,000,000 sheet is modified.

MODERATOR BUMSTEAD: Thank you, Mr. Chamberlin.

MR. WALTER W. ROMIG: How is the selection of the projection dependent upon the latitude of the center? In this case, suppose North America had a center at the equator.

MR. CHAMBERLIN: If you are using an oblique projection, or any one of the normal projections inclined obliquely, such as the azimuthal equidistant, it holds its scale true no matter where you put it. The same general standards are true. If you are using a transverse projection or an oblique projection on a great circle, either a transverse polyconic or transverse Mercator, it doesn't make any difference where you acquire it.

Usually, I like to forget all about latitude and longitude until I have chosen the spherical section I want to represent.

One other consideration comes in here. If you are making the map of Asia, you have very little interest in the center of the map. That is a country that you know very little about. No one goes there. It is not of geographical importance, yet. You want to throw your least amount of error around the periphery which includes the Continent of Europe, Japan, and the China coast. So that would influence your selection.

Of course, if you were thinking of the application of the conic projection just in normal cases, there your latitude is very important as to where that will apply.

MR. S. W. BOGGS (Special Advisor on Cartography, Department of State): In speaking of the separation colors in the compilation drawings, no mention was made of any colors other than blue being non-photographic. Is there any use made of non-photographic pinks and purples to any extent?

MODERATOR BUMSTEAD: Mr. Hanson Hoen, would you like to speak on that?

MR. HOEN: We have made all corrections in the non-photographic pinks and also the non-photographic purples along with the light blues, and they prove very satisfactory.

MR. MAURICE S. A. DELANEY (Hydrographic Office): Mr. Chamberlin, is there any way to identify a projection on a small-scale map?

MR. CHAMBERLIN: No, not with certainty. Of course, you can look at your map and compare it with one that does have the lines of meridians and parallels on it, and sort of judge roughly where they go, and guess your projection.

MR. DELANEY: What type of projection was on the aerial photograph that was taken from the V-2 rocket, assuming the photograph to be a map?

MR. CHAMBERLIN: Of course, if you just photograph the globe from a considerable distance away, you are turning out an orthographic, and any particular small feature in that picture would be an orthographic projection, but the whole thing, I should think, would take some modification in stereographic. It would be so modified, I don't know what you would call it.

DR. CLARENCE B. ODELL (Encyclopedia Britannica, Chicago, Illinois): I would like to ask Mr. Heintz or Mr. Hoen if the non-photographic blue boards can be made photographic through the use of special lights or filters. In other words, can you make a blackline from a blue board?

MR. HOEN: I am not so sure you can do it, to tell you the truth.

MODERATOR BUMSTEAD: If he is not so sure you can do it, I would say the answer is no.

MR. HEINTZ: If you did do it, you would ruin your black. If you got the blue up at all, your black would be very heavy.

MODERATOR BUMSTEAD: I take it it isn't a good idea.

DR. ODELL: If there were only blue on it, no black?

MR. HEINTZ: It depends how dark the blue is. You know you can use panchromatic plates and yellow filter and photograph any blue unless it is so pale that you can hardly see it. If you were just shooting for the blue, using panchromatic plates with the yellow filter, you could get it; but if you have black on there at the same time, why, your black is going to come up quite heavy, because the exposure is way overexposed to black.

MR. DAVIDSON: Mr. Bumstead, that is a problem which we meet quite often in compilation. Unfortunately, the blue ink that is used on most printed maps is not always photogenic, as Mr. Dix said, so that when we want to use published maps as source material, and want them photo-copied, I can remember the time when we retraced all of the drainage in black. But the development of new films and filters, and all those things has made it possible for us to sometimes copy it twice, once to get the blue, and another time to get the other colors, if we need them.

MR. DIX: The thing that has not been mentioned, I believe, when you asked whether the blue can be photographed, is that it can be photographed into a tonal plate; but you could not use the negative to make something else in the photomechanical line. You would get a faint image, even a ghost image, but you could not use it as a transparent window for making a photomechanical plate or anything of that nature.

MODERATOR BUMSTEAD: I see in the audience a man who can tell us all there is to known about this question. As a matter of fact, he is on the program for this afternoon. He is going to speak on the Her-Sol process, which involves doing the impossible. Mr. Materazzi, would you like to talk for 2 minutes on that right now? Come up here and use the microphone.

MR. ALBERT R. MATERAZZI (Graphic Arts Specialist, Aeronautical Chart Service, U. S. Department of Air Force): Thank you, Mr. Bumstead. This problem of photographing blue on a blueline board, if you have just a blue line image, with no black drafting on it, as Mr. Heintz pointed out, it can be done by the use of a red filter on a panchromatic plate. The problem of getting a blue image off of an existing map, which Mr. Davidson mentioned, that, too, can be done by judicious selection of filter and emulsion.

The Her-Sol process makes it possible to pull the blue out by itself without any of the other features, provided the original map is transparent.

I do not think that there is any question that, for limited amount of detail or if you are not going to use the subsequent negative for reproduction as such, you can get an image from an original blue.

MR. S. SACHS (Coast and Geodetic Survey): I would like to add a word to that in the matter of getting the reproduction negative. What we have done in a similar circumstance.

MODERATOR BUMSTEAD: Mr. Sachs, are you going to tell us something, or are you going to ask us something? I would like to have you come up here if you want to add to Mr. Materazzi's remarks. Will you do so? Mr. Sachs busies himself with trying to do impossible things down at the Coast Survey.

MR. SACHS: I was going to say that another approach, going a step further, in the endeavor to get a negative for reproduction purposes, is to take that panchromatic negative that has been made and build up contrast by using the conventional contrast emulsion on any dry plate. We have done that. Sometimes you may need to do that by going through the process twice. If you have a great deal of work, it will be warranted to avoid the redrafting. It is entirely practical, and we have done that.

MR. EDWARD W. FONFARA (Hydrographic Office): Mr. Chamberlin, will you kindly explain the difference between the inverse, transverse, and oblique Mercator?

MODERATOR BUMSTEAD: If he will, I won't let him. I will give him 2 minutes to tell why he won't do it. Is that all right, Mr. Chamberlin?

MR. CHAMBERLIN: Well, the Army and the Air Forces in conferences decided those definitions, and I think that they followed pretty much the same definitions that we have followed. We have gotten into some trouble on them, some criticism.

The late Mr. Deetz of the Coast and Geodetic Survey really decided our definition. We talked to him a lot about it, and he said that there was no distinction between the transverse and the oblique Mercator, that the oblique was just a different part of the transverse, a use of a different section of it. So we have followed in our own work the definition of calling any Mercator that did not follow the equator a transverse Mercator.

Usually you think that, as a definition, the transverse Mercator follows the meridian, or is based on the meridian instead of the equator, and an oblique Mercator follows any other great circle, or is based on any other great circle. The inverse I should know and don't. I can't give you a definition on that. I am just not prepared on it.

MODERATOR BUMSTEAD: Mr. Fonfara, would you like to come up and say a word on that?

MR. FONFARA: Basically, what Mr. Chamberlin says is correct pertaining to the inverse Mercator projection. That is simply the transverse Mercator projection with the mathematical name. It is a 90° transpositional pole, and of course the oblique Mercator projection is assuming any great circle as the central meridian in your transposition, and determining your angle of transformation from your true meridians to this great circle.

MODERATOR BUMSTEAD: Thank you. I did not think you could say it that quickly.

DR. A. C. SIMONPIETRI (State Department): My question is directed to Mr. Heintz. I think he suspects it is possibly coming. About 3 years ago Mr. Heintz did a very creditable job of reproducing some very old maps for the Venezuelan Government in preparation for a historical atlas. I recall the old ones—English, Spanish, Italian, and even Dutch maps which were done at the time. Some of the copy was pretty terrible. I wonder if any particular tricks would come to mind that you could tell us about this morning?

MR. HEINTZ: Each map, especially an old map, presents itself as a problem, and each one has to be treated as an individual. If a map has become so badly yellowed with age, and the ink has faded so brown that there really is not very much distinction between the browns of the ink and the browns of the old paper, then you have practically no choice except to reproduce that map as a halftone. In that case you get all the tones on the paper. But that is an extreme case.

The other cases are those in which you have very faded lines and brown paper. It is not possible to say there are any special tricks, or how to do it, it is merely a question of the skill of your photographer in bringing out those contrasts, and his use of the proper type of film; and then, of course, there has to be a certain amount of handwork in bringing back some of this that just will not photograph. That is the best way I can answer your question.

MR. HOEN: What Mr. Heintz said would apply to all of us. Each map represents a different problem, and when you get that yellowing of the paper, and the black ink turns to brown, you really are in plenty of trouble.

MODERATOR BUMSTEAD: Thank you, Mr. Hoen and Mr. Heintz. I might say again that Mr. Materazzi's talk this afternoon is going to describe a method, perhaps the most advanced method, for doing this kind of work; that is, reproducing, or rather making, printing plates for a produced map.

MR. J. P. GALVIN (Army Map Service): How do these civilian outfits go about properly delineating boundaries of foreign countries? Where do they get their information?

MODERATOR BUMSTEAD: Mr. Boggs of the State Department could say something about that if he would like to. Would you, Mr. Boggs?

MR. BOGGS: I wonder if it would not be better for the National Geographic to answer how they do it. They do a good job.

MODERATOR BUMSTEAD: Mr. Chamberlin, would you like to say something about that? The Moderator decided he had enough to do without trying to explain anything.

MR. CHAMBERLIN: I see that Mr. Grazzini is in the audience, and I would like to duck that and give it to him.

MODERATOR BUMSTEAD: Mr. Grazzini, would you like to say a few words about that? It isn't that we don't want to tell you, we just want to be sure that the right person tells you.

I think Mr. Grazzini had better come up here. This just does happen to be Mr. Grazzini's job with the National Geographic Society. He figures out boundaries.

MR. ATHOS GRAZZINI (National Geographic Society): Well, first I might say we do consult the State Department many times. But on the other hand, there are some boundaries that we show on our maps which we think are there from a practical point of view. For example, we just completed a map of Europe, and we proceeded to show the boundaries according to the treaties recently signed, and also according to the claims of the Russians and the Poles.

We have had some criticism along that line, saying that we should not do that, that we often might put our government in a very bad position. Well, we look at it from the practical point of view. For example, everybody knows that the Baltic states are a part of Soviet Russia, even though we do not recognize that in this country. If you want to do business with them, you have got to do business through the Russian government. If you want to send mail to those countries, you have to send it to Russia.

And the same is true in Poland where the Poles have deliberately stepped over to the Oder River and taken over, lock, stock, and barrel, that German territory.

We maintain that the Poles are administrating that territory, that they have taken over the school system, they have taken over the transportation, they have taken over everything. And from a practical point of view, that is Polish territory.

We get the information principally from what is going on there. We have all kinds of information from Poland. We have all kinds of statistics. They have run all the Germans out of that territory. Official Russian maps show these new boundaries.

MR. BOGGS: I did think it was very appropriate to refer the question to the National Geographic Society, because they do a very good job in a very difficult situation, and I am very glad Mr. Grazzini answered the question. It did seem to me I could add a word or two appropriately, and I am glad to do so.

The matter of the boundary information or political information of any sort on maps published by private publishers and by various departments of the government is a matter of very considerable interest and importance to the government and one that is sometimes of real concern. And the larger the edition, the more widely circulated the map, the more interest it has, in one way or another, to the government. Therefore, the government departments, the State Department included, are generally ready to cooperate as fully as they can with any publisher who asks intelligent questions in this regard.

But all that can be done in a country like this, a democracy, as we call it, is to say these are the facts as we see it, this is the way we would interpret it if we were making the map, but you are free to do as you please about it. If you regard it as a factual situation, and think that, after we have told you all the pros and cons as we see it, you want to do it another way, there is nothing the government can or should do to prevent it, I should say, or to influence them further.

But it is a matter that I think the private publishers might well realize greatly affects other countries or other people. I can recall a case—I probably should not mention the country concerned—where in a certain privately published map the boundaries were shown as so-and-so; that country was greatly concerned about it, and I was told that the cables almost every day for a week or two brought in questions about that map, from the point of view of some of these other countries whose systems of government control were very different.

Their point of view was, "We can't believe that a country exists where a private publisher has such freedom to do as he pleases." We think that must have been a trial balloon, to see how it would be accepted.

I just mention that as a factor that I thought would be of interest to publishers here to know how much it is of concern at some times.

MR. JAMES RAY (Bureau of the Census): I do not know why this question was limited to boundaries of foreign countries. At the Bureau of the Census we have been spending these last 9 years trying to establish the boundaries of some two hundred thousand, more or less, major or minor political divisions within this country. There are many of these questions that have not been settled. In addition to these two or three hundred thousand boundaries, there will be an equal number of special census boundaries, and we are working very hard out in Suitland trying to resolve these questions by next April.

MODERATOR BUMSTEAD: I think all of us would be surprised, and many of us often are, to see how fully defined some of the boundaries in this country are. It is remarkable.

I believe Mr. Helmuth Bay has a question.

MR. HELMUTH BAY (Rand-McNally & Company): I would like to say a little bit about this boundary business. I am just trying to defend the idea of trying to show boundaries as they are. The businessman, if he was making a trip to what is now Manchuria, while it was called Manchukuo, had to go to the Japanese to get a passport, and not the Chinese who had actually lost control.

We tried our best to cooperate with the Department of State as closely as possible, but boundaries simply cannot be shown except from the practical standpoint, as the gentleman from the National Geographic said a moment ago.

There are some curious things that happen. For example, there was a boundary dispute between Ecuador and Peru some years ago. So we wrote to the geographic society of Lima, and to the Ecuadorian government and got the official boundaries as claimed by both those countries. Then we showed a disputed area, between the two claimed boundaries. The first thing we knew there was a law passed in each country

that no maps could be imported for that country unless they showed the boundaries in accordance with the decision of that country. So, if we sold maps to Ecuador, we had to show them the way Ecuador wanted them; if we sent them to Peru, we had to show them the way Peru wanted them.

Then a big steamship company wanted a map of South America. We put in the disputed boundaries, and they shipped them all over Latin America on calendars or something. Well, here were two countries which would not let the maps in, and the steamship company insisted on reparations, in spite of the fact that both our boundaries, I think, were absolutely correct for each country.

When we removed Czechoslovakia, after it was forcibly occupied, there was really Cain raised. I got phone calls in the office in Chicago from people calling me a Nazi and a Nazi spy, and some even threatened to kill me. I also had the Chinese on my neck, and later the people from Lithuania, Estonia, and Latvia.

Every time there is a dispute like that, the easier thing would be to show the boundaries as we would like to have them be. But we can't do it. And even, I think, with due respect to the State Department, when it comes to the question of their people moving about, they have to take into consideration the de facto boundaries that are shown on the non-government maps.

It is a tough problem. You are going to hurt somebody either way you do it.

MR. BOGGS: Mr. Chairman, if there is time, I wonder if it would not be desirable to hear from Mr. Lohse with regard to problems of this sort faced by an international organization.

MODERATOR BUMSTEAD: I think it would be a fine idea. Mr. Lohse, would you care to come up and say a few words?

MR. KARL LOHSE (International Civil Aviation Organization): In ICAO we have the problem very often to indicate boundaries of various states. As a matter of fact, it is a very serious problem, to be avoided as poison.

In the aeronautical chart section we recognize only the jural boundaries. In the absence of peace treaties, we take the boundaries as they existed as of 1939.

We had a very sad experience in the early days of the organization when one of our contracting states drew a beautiful map for us and it indicated certain boundaries as belonging to another country, and after that we started writing a great many letters apologizing: "Sir, I have the honor to admit that we made a mistake," which we didn't make.

We have, I believe, solved the problem, in the absence of treaties, by merely using geographic coordinates from one line to another, where a state is exercising de facto sovereignty. We do not determine the boundary. We merely say from such-and-such a point to such-and-such a point is where they exercise sovereignty, but the area doesn't belong to them by any means; the boundaries are shown as they were in 1939.

In the case of, for example, Pakistan and India we have obtained very large-scale maps from the respective governments, or boundary commission reports, and these are used to determine our boundaries. Aside from that, the Statesman's Yearbook and the U. S. State Department are a godsend to us.

MR. FONFARA: I would like to direct this question to Mr. Davies. In the matter of plotting on distorted projection, assuming that you have source material that is one type of projection and you want to plot it on a very distorted projection—say the azimuthal—how would you go about it?

MR. DAVIES: That problem comes up quite often. There are a number of ways. You can take part of your distortion photographically. It is very much like using calculus, if you keep your unit with which you are dealing extremely small, the unit distortion, therefore, is extremely small, and the more numerous your units, the more easy it is to get around the distortion. In other words, if you are using a whole bunch of film negatives each an inch square, you can slice them up in such a way that you can account for your distortion.

It is quite common that on many maps being compiled, in order to introduce the proper distortion in the source material, that a film negative will be laid down in wet form and actually stretched into position. Of course, you cannot use too big a negative.

Another method is by use of comparable squares, which is probably the easiest method and the quickest. It has found less use of late, actually, because there is a tendency in cartography to remove the manpower as much as possible, and photography has taken over considerably. But comparable squares are certainly one of the best answers. In other words, line off on your source material a set of rectangular coordinates, and take those same comparable coordinates and lay them off on your new projection, in which case they will be automatically distorted. Then lay in your information according to that.

What you need to do is photograph them by stretching negatives and cutting them up, what is known as scissors cartography. The surveyor, I think, frowns terribly on that, but considering all the other stretches that go into distortion cartography, this the most innocuous, or we come to the square method, either one.

MR. DELANEY: Mr. Heintz, when you are photographing a foreign map that is supposed to be rectangular, and it converges a little at the top, is there any means you have in your copyboard that you can fan that out so that when you do get a photograph you will have a square rectangle?

MR. HEINTZ: Yes, it can be done if you have a camera that is obliquely adjusted. You can, by adjusting the back end of your camera in or out, change the distortion. However, we don't like to admit we can do it, because too many customers want it done. It is an expensive proposition. Then they don't want to pay for the time that it takes to realign your camera, and so forth.

We have that problem, I wouldn't like to say with whom—a certain government department for whom we have made a number of negatives. We received a copy and they gave us four dimensions to make the copy. It is to be reduced to these four dimensions. But when your camera is square they won't come out that way. So you have to juggle your camera around until it does come out that way. And then they scream because the cost is so great. Well, it just takes a longer time, that's all, but it can be done.

MR. DELANEY: Do you do it with one exposure or do you have to take two exposures?

MR. HEINTZ: It depends. Let's be practical. You can't go way out, because when you distort your camera, you are also distorting your focus, and if you go too far, your lettering is going to be blurred, and so forth. So we make but one exposure. In other words, we would not make it any more distorted; we cannot correct any distortion greater, probably, than 1/16 or 1/8 inch. But you could not take something that is a half inch out of square and square it up to the camera. I recommend scissors cartography for that.

MODERATOR BUMSTEAD: Mr. Dix seems to have some ideas on this question.

MR. DIX: I think from Mr. Delaney's question, whether there was a double exposure process there, that he may be thinking of the double negative method of making either a rectangle square or a square into a rectangle, which is done by keystoning rectification by slip axis. You distort the first negative by tipping the copy in the negative to get a keystone, and slipping the axis one way or the other to bring the thing into position. You reverse the process and you get a slip scale image.

Another way—just a single tip—as the conflict with focus changes, the dimension does not move the same in both directions. In the former method, you can come out, but it is not a practical method.

MODERATOR BUMSTEAD: I gather the best thing to do is to draw the thing right in the first place. I might say that these lithographers are able to do things without trying, as concerns making rectangles to other shapes.

MR. FONFARA: That is what I was going to say. The press can do that unconsciously when they put too much pressure on the rollers.

MR. GAZZINI: I have a question here either Mr. Davies, Mr. Davidson, or Mr. Dix can answer. From the time the source material is gathered to the drafting of the map, there are bound to be differences of opinions as to how reliable the material is that goes into that map. I just wonder how they get together on that.

MR. DAVIDSON: I seem to be in the middle of this. Source material, as it has been mentioned, is gathered in greater quantities than we will ever use. And the gathering of that does not always, and I say this depends on the way the organization is set up, carry with it instructions as to just how to use this material.

Of course, there can be a difference of opinion which would have to be ironed out then between the map research people and the compilers, but in a great many cases, the choice is left to the compilers; the job of research, as I understand it, the collecting of the maps is a sufficiently difficult one, and if they were to take each separate map and compare it to all the others, and analyze the discrepancies and everything, in effect they would be doing about half of the compilation job.

Now, provided that we can agree that far, the person who is responsible for the drafting would be given fair copy, and he would simply follow that copy. That is the way I understand that problem.

MR. DAVIES: That boils down to two kinds of discrepancies. You have the actual discrepancy in which you have diametrically opposed conditions. One fellow says it is a road there, another fellow says a railroad. Then you have the other type who says the stream has a general northeast direction. Both maps show it that way, but each one shows it differently, by little curves and arcs in the mountain system. The latter part can be solved only by the compiler, because it is one of those things you have to talk about and decide one way or the other as best fits conditions.

The worst is the factual condition. That goes back to the problem of digging through what we now call intelligence—digging through intelligence and getting the answer.

The point is, though, that it is practically impossible for anybody to fake a map. That is one thing that cannot happen. So you don't have to worry about it. The main thing is just

change in conditions. You can detect a fake map in a matter of seconds.

The main thing is to go back and check for facts, and you go through your whole process then and get the information.

MODERATOR BUMSTEAD: Does that answer the question?

MR. GRAZZINI: In Mr. Dix's case he says he is given copy. Does he take that and just put that in exactly as it is given to him? I mean his men that are drafting that map, if they are alert, they are going to pick up things. They might say, "This is not so good now."

MODERATOR BUMSTEAD: The compilation man has made a compilation drawing and he says it is all right, so he turns it over to the drafting department, and presumably the drafting department will not question anything on that compilation drawing. They will simply turn a rough compilation drawing into a finished piece of copy for reproduction.

Your question is, what happens if the copy preparation department begins to suspect the validity of something on the compilation drawing?

MR. GRAZZINI: That is right. I realize that in a large mapping outfit there have to be distinct departments or sections, but in smaller agencies, like at our place, you might say that the man that does the drafting is pretty much on his toes about compilation and he is also pretty much on his toes about the source material.

MODERATOR BUMSTEAD: I think you raise a good point there in that you cannot draw definite limits around the separate parts, separate branches, separate activities within the field of cartography. They must overlap, and we have found that it is very well for each man to understand the other man's work. I think that was in the back of Mr. Grazzini's mind.

MR. GORDON LITTLEPAGE (Coast and Geodetic Survey): Mr. Davidson, I suppose in your map of North America you do some trimetrogon bases. I would like to know what you consider the relative accuracy of those bases with reference to standard map accuracy for 1: 250,000 map scale.

MR. DAVIDSON: The question is a little difficult to answer because, in the course of the development of the trimetrogon method, there probably have been in some places in Alaska as many as four or five different bases compiled and used. So that I think before we even try to answer it, we would have to say, do you mean a trimetrogon base that was completed, say, 6 months or a year ago with the advantages of all the additional control, or do you mean, perhaps, the very first trimetrogon compilation which we accomplished back in 1941.

MR. LITTLEPAGE: I mean your last one, 1946.

MR. DAVIDSON: I would say then that for the 1: 250,000 scale the trimetrogon compilation would be the equal of any other 1 : 250,000 scale compilation, provided the same control were used.

MODERATOR BUMSTEAD: We have already run over our time by several minutes. I think now I will turn the meeting back to Mr. Crump, who has a few announcements.

CHAIRMAN CRUMP: I am sure you will all agree that this has been a very interesting session. We hope to have more of them, possibly one during the middle of the year, or a fall session, perhaps.

When I asked Mr. Newman Bumstead to take over this panel discussion and arrange all the details, and speakers, and so forth, I had no fear but what he would do an excellent job, and I am sure you will agree with me that he has, together with his various panel members. I am grateful to both him and the panel for their splendid participation in this program. I think you will agree again that, so far as this annual meeting is concerned, cartography has played a large part in the entire program.

If there are no further comments, I will adjourn the meeting.

(The meeting adjourned at 11: 35 o'clock.)

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Property Surveys Division

EDITOR'S NOTE.—The session of the Technical Division of Property Surveys was held at the Ninth Annual Meeting at 9:30 o'clock, June 9, 1949, in the Capital Room of the Hotel Statler. Mr. S. A. Bauer, Cleveland, Ohio, Division Chairman, presided.

CHAIRMAN BAUER: First, I will give a summary of the status of the division activities to date. Our first effort was to develop the Standards of Practice, which were adopted by the Congress in 1946. Since then, a large number of copies of the Standards have been circulated throughout the country. During the past year, reprints on a single folded sheet have been made by the Congress and are available to the membership for a nominal charge. Anyone needing them can obtain them by writing to me. Some men are using them as inserts when submitting estimates or proposals on work for the purpose of indicating the methods by which they work.

But the fact that the Standards were drawn up, approved, adopted, and circulated does not end the job. If the Congress is to remain active, it must educate the profession to those Standards. We are going to accomplish much more for ourselves by raising the mean level of professional activity than we are by any legislation or any strong-arm methods.

I had a call last week from a man who is employed by our local gas company. He had just become registered the previous week and wanted to know what is required in making lot surveys. He had no idea what was involved, but he was registered and was going to make surveys. Men like that must be educated, and our Standards are a method of such education. We must circulate the Standards among such men; we must hammer them home. Every member of the Congress should act as a committee of one in that educational campaign.

Next came the Fee Study, which was completed this year and accepted by the Board of Direction of the Congress. You have all seen the report. The Fee Study does not fix prices; it merely establishes the criteria of charges, and ties them into a proper service, a proper service being defined as the Technical Standards. Copies of the Fee Study are still available. Many have been distributed to non-members. Circulation of these documents is, in a large measure, advertisement for the Congress. But, more important, I think, is the fact that these documents are doing much toward educating the profession to a high level of practice. Our job in the Congress is primarily one of education.

Our next problem started at the Annual Meeting last year. It involved the question of a textbook or handbook for the profession. Mr. John Goggin, of Clare, Mich., made the statement at that meeting that it is strange and sad that ours is probably the only profession in the country that has no book devoted specifically to the profession. There are a large number of textbooks on surveying, but there is no textbook or handbook that is keyed directly to the practicing property surveyor. A committee was appointed to develop a Table of Contents for such a book, and Mr. Goggin was made Chairman. To date he has assembled many opinions from men around the country. The process of crystallizing

and simplifying the various ideas into chapter headings remains to be done. There is a possibility that we may have stirred up some interest in this idea of a broader sort that might lead to some notable results.

The next project was Specifications for Property Surveying Procedures, compatible with the Technical Standards. In these Specifications we attempt to determine the *how* of procedures.

These are the four major projects of the division since its origin and cover the back history of the division to date.

Now for the most pressing business of the Division—the matter of officers. The constitution of the Congress is not clear on how the officers of a division are to be elected. When the Property Surveys Division was formed, I was appointed chairman by the President of the Congress. I appointed certain other officers provided for by the constitution. More men were added to this list from time to time, and served with the officers as an Executive Committee to carry on the activities of the division. There was nothing too formal about the arrangement, and in all discussions we tried to pull in as many men as possible.

At present it looks as though I stand at least a 50–50 chance of becoming president of the Congress for the coming year. If selected, I will have to give up the chairmanship of this division, although I think it is about time I did so anyhow.

There has been some discussion between the chairmen of the various divisions as to the method to be used to appoint officers. The Cartographic Division has worked out a set-up which I should like to read to you in part.

"All members of the American Congress on Surveying and Mapping are eligible for membership in the division.

"The officers of the division shall be a Chairman, Vice-Chairman, Secretary, and an Associate Editor. These officers, together with six directors, shall constitute the Board of Direction of the division. The term of the chairman shall be 1 year.

"The directors shall be elected by the members for the term of 2 years. Each year, two new directors will be elected. An executive committee composed of the officers, directors, and committee chairmen shall be called into session at the discretion of the chairman. Vacancies are to be filled by the chairman, subject to confirmation by the board. Chairmen and directors shall be elected by letter-ballot preceding the Annual Meeting of the Congress. The vice chairman, secretary-treasurer and associate editor shall be appointed by the chairman, subject to confirmation by the board. The nominating committee, appointed by the chairman, shall prepare a ballot to be mailed to the membership of the division 60 days before the election. The ballot shall consist of one nomination for chairman and five for director, of which two shall be elected.

"Annual meetings shall be held each year to coincide with the Annual Meeting of the Congress. Other meetings, as may be deemed desirable, shall be held at the discretion of the Board of Direction."

There is no requirement that all Divisions follow the same outline; in fact, it is recommended that each Division work out its own solution for the purpose of keeping it operating as actively as possible. The Cartographic Division is more favorably situated in that many of the men are located here in Washington. The Property Surveys Division is scattered all over. We do not have a large number of men in any one place, and there is some question as to whether or not we can work with this set-up.

I would like to hear suggestions from the floor as to the best method of operating. First, what should we do about the immediate present, as far as carrying the division over the interim period; and, second, what will the set-up be as a permanent mechanism for the appointment of officers?

DISCUSSION

PROF. F. C. MIRGAIN (Cooper Union): Can you enumerate the other officers of the Division?

CHAIRMAN BAUER: Mr. Owens of Kansas City, Mo., Vice Chairman; Mr. Kahn of New Haven, Conn., Treasurer; Prof. Earnest of Case,

Chairman, Program Committee; Mr. Wattles of Los Angeles, Calif., Chairman, Technical Standards Committee; Mr. Goggin of Clare, Mich., Chairman, Textbook Committee; Mr. Berry of the Coast and Geodetic Survey, Chairman, Membership Committee; Prof. Dodds of Iowa, Chairman, Research and Development; and yourself—I do not know whether I gave you any particular name, but you were on the Executive Committee. There were 10 or 15 men who formed the group that I depended upon for any decisions.

Now, actually, the names are relatively unimportant. The important fact is that we had several men whose opinions formed the nucleus of any actions that were taken by the division. If your question implies any recommendation, I will say that I personally would recommend Mr. William C. Wattles very highly, if he will take the job, as Chairman of the Division, on two counts—one, extreme capability; and, two, a lot of energy which he has expended in behalf of the Division in the past. On the basis of his past record, I think he would be as good as any man we have. But I am entirely open to any suggestion. My opinions are not paramount.

PROF. MIRGAIN: My own feeling is that we don't need any elaborate organization. There are four officers and six directors mentioned. That seems like quite a large number, and I don't know whether it is necessary to have this many. But the one thing I don't think necessary at all is any kind of letter-ballot. It seems to me that officers could be determined and elected at an Annual Meeting such as this.

CHAIRMAN BAUER: There is a difficulty with each of the suggestions. With regard to the letter-ballot, I don't believe the Congress really knows which are the primary interests of the members of the Congress—whether they are primarily interested in property surveying, cartography, and so on. I don't believe there is such a compilation. Futhermore, the mechanism of circulating ballots is apt to be cumbersome. None of us has so much time to spend that he can afford to waste it on pure mechanisms. I would prefer to see such time and effort spent on things that are accomplishing actual good. So I agree with you on the matter of the absence of formality for formality's sake. The only difficulty at the Annual Meeting is the fact that we don't have a large representation, and there might be some accusation of undemocratic action.

PROF. MIRGAIN: It isn't common practice, in various societies, to elect division officers formally. Very few societies take the trouble to go through that. After all, every man has the privilege of attending a meeting or indicating to the chairman his choice of candidates.

CHAIRMAN BAUER: I agree with you on that point, and I feel quite strongly on the matter of a lack of protocol. I would like to see all effort put forth in the direction of accomplishment rather than spent in the mere matter of appointing officers and circulating ballots and this and that and the other thing. It is necessary for the parent body; I am just a little dubious whether or not it is workable in the division.

What other suggestions do you have?

PROF. MIRGAIN: I think what we need in the division is a chairman, a vice chairman, a secretary, and possibly three directors, making a group of six. Probably the way to arrive at the directors would be to have a 3-year term with one director appointed each year. To get started, of course, we would have to appoint three, with terms of 1, 2, and 3 years. In order to move the meeting along, Mr. Chairman, I would move that we organize the division along that line, with a chairman, a vice chairman, a secretary, and three directors.

CHAIRMAN BAUER: The constitution provides there shall also be an associate editor, so we will want to include that.

PROF. MIRGAIN: It seems to me that might well be tied in with the secretary's work, because he would have all the minutes of the proceedings and it would be a logical coordination.

CHAIRMAN BAUER: It might well be the same man.

MR. W. B. WILLIAMS (Grand Rapids, Mich.): From my experience in the Michigan Surveyors' Society, I find that surveyors are very poor correspondents. I think it is an excellent suggestion that the officers be elected at the Annual Meeting. As far as the lack of representation goes, you have the same thing in all professional societies that I know of. The assumption is that those sufficiently interested to attend the meeting are the ones who have the interest of the organization at heart and are the representatives of the others. I think the suggestion should be carried out. I second the motion.

CHAIRMAN BAUER: Any other suggestions? The motion is that we name, at this meeting, a chairman, vice chairman, secretary, associate editor, and three directors for the division, to serve varying periods of 1, 2, and 3 years.

(The motion was voted upon and unanimously carried.)

I will now entertain a motion for either the nomination of men to those offices or a motion for a mechanism to name those men to office.

MR. WILLIAMS: I move the Chairman appoint a nominating committee to present a slate.

PROF. MIRGAIN: I would like to comment on that motion, Mr. Chairman. I suspect that most of us here know one individual who is probably familiar enough to do a job. On the other hand, I don't know that this particular matter, at the moment, is so important—that is, the personnel. The important thing is to get the nucleus, get the organization rolling, and then, in time, it will move along. I wonder if, just in the general caucus session, we couldn't discuss various individuals and possibly arrive at a slate of officers. A nominating committee, not being familiar with each individual, would have difficulty. Possibly if we work as a committee in this room, we might arrive at a satisfactory slate, elect it, and proceed from that point.

Now, it is conceivable that some men we select will find it necessary to turn down the selection. Of course, that still is possible with the nominating committee. It seems to me that such a procedure would at least get us going, and I don't think there would be too much objection if the Chairman just filled any vacancies for this year.

CHAIRMAN BAUER: What you are driving at is that this entire meeting be the nominating committee.

PROF. MIRGAIN: Right. You have suggested Mr. Wattles as chairman. I certainly concur in that. Other men here might have some ideas of individuals they know who might be interested in working in this Division.

CHAIRMAN BAUER: Is it agreeable that the entire meeting be the nominating committee?

MR. WILLIAMS: I was just thinking, Mr. Chairman, that it is getting late; and, if we go into that, it is apt to drag out for another half-hour. I think you and the professor here are probably more familiar with these individuals than are the freshmen at this meeting.

CHAIRMAN BAUER: What we need are workers, and whether or not the men have ever been active before, if they are workers and have something to give, they are an addition. The freshmen can do just as much as any others.

MR. WILLIAMS: I have no objection.

CHAIRMAN BAUER: May I take the bull by the horns and proceed on the assumption that this is the Nominating Committee and throw the meeting open to discussion for nomination to various offices? Let's just throw the ball around for a while. Let us assume, first, that we are just throwing in names of men who are competent and men who are on the right side of the fence and willing to work.

In all such organizations, most of the work falls on the chairman, and his success depends on how much he pushes the thing along; not necessarily on how much he does himself, but how much he eggs the other fellows along. The chairman does not get quite a volume of work. The work on the part of the others is primarily a matter of cooperation, and in terms of time it is not excessive. But the other men are extremely important. The chairman can't do very much by himself; he needs the support of the other men. He needs their advice, even if it is only a word here and there. I can say, having had about 5 years of experience, that it is not a mere matter of saying yes to everything the chairman proposes. That is not always entirely helpful. Very often, it is helpful to have a frank discussion of what goes on—suggestions for change and so on. So the chairman must expect to have a load to carry. From the standpoint of the others, it is not a terrific amount of work, but it does mean support and active interest. That might color, a little bit, the matter of naming candidates.

(The names of Messrs. Wattles, Berry, Stroebel, McCammon, Mirgain, Lundgren, Goggin, Daniels, Hemming, and Teas were mentioned as possibilities for officers and directors.)

May I suggest that we work tentatively in this schedule and later on I would entertain a motion for some flexibility in the event this doesn't quite work out. But tentatively, let us work within this list and try to specify one or two men for specific jobs.

(By unanimous vote the following officers were elected for the coming year: William Wattles, *Chairman;* Ralph Berry, *Vice Chairman;* Robert McCammon, *Secretary-treasurer;* and John Goggin, *Associate Editor.*)

CHAIRMAN BAUER: Now, there are six names, in the following order, that have been proposed for three directorships: Messrs. Mirgain, Stroebel, Teas, Lundgren, Daniels, and Henning. What is your wish?

PROF. MIRGAIN: Mr. Chairman, I move that you, as Chairman of the Division, write letters to these men until you have three directors.

CHAIRMAN BAUER: Is that a motion?

PROF. MIRGAIN: That is a motion.

(The motion was seconded, was voted upon, and carried unanimously.)

CHAIRMAN BAUER: I think we have officers set up for the coming year, and I will do the necessary correspondence and notify the division of the results.

Now, the matter of new business would involve anything you might want to bring up. Probably it should concern what direction we should follow in the future.

MR. WILLEY: Mr. Chairman, would a motion be in order that the officers for next year bring in the slate of officers for the ensuing year?

PROF. MIRGAIN: If that is a motion, I second it.

CHAIRMAN BAUER: I will accept the motion that the newly appointed officers be authorized to appoint a nominating committee to name the necessary officers for the coming year.

MR. WILLEY: To present to the Annual Meeting next year a slate of officers.

MR. McCAMMON: Is there a roster of the members of the Division?

CHAIRMAN BAUER: Officially, I don't know of any.

PROF. MIRGAIN: It seems to me that some years ago Secretary Dix sent out cards to the members. It may possibly be that he has a roster.

CHAIRMAN BAUER: I do have one of the original rosters, but, of course, it changes from time to time with the change of membership. But there is a partial one, at least. The only question is whether it is up to date. Are there any other questions on the motion? If not, I will call for a vote.

(The motion was voted upon and was carried unanimously.)

There is one more thing. I do think that the officers should appoint a committee to set up by laws to determine terms of office and a few other things. I think it should be extremely simplified. But I would entertain a motion to authorize the new officers to develop bylaws for the Division.

(Upon motion regularly made and seconded, it was voted to authorize the new officers to draw up the bylaws as described by the chairman.)

Now the meeting is open to you gentlemen.

MR. McCAMMON: Well, I have a problem in the State of Vermont about the registration of surveyors. A lawyer came up from Brooklyn, but he wasn't getting any business. So he decided to be a surveyor. He bought a compass and he started up. He has made such a mess that I don't know if I can straighten it out. He ignores all the lot lines established in 1845. He comes in and throws a 30° angle and lays out the man's lot. Of course, they want to bring the case to court. It is going to take a lot of investigation to determine the old lot lines and put this one small lot, which falls in the northeast corner of this lot, in position.

CHAIRMAN BAUER: Do you have a registration now?

MR. McCAMMON: Not for surveyors.

CHAIRMAN BAUER: I would like to add this to the picture. In Ohio, we have a surveyors' registration law, a law for engineers and a law for surveyors. Any civil engineer, as far as the board is concerned, can practice surveying. But no surveyor can practice engineering unless he is registered as an engineer. The peculiar part is that, under the registration law, a surveyor must have the same education and experience as an engineer—4 years of college and 4 years of experience—except that a surveyor must have 4 years of experience in engineering and surveying, whereas an engineer only has to have 4 years of experience in engineering. Now, there is a State where we have a registration law almost 15 years old. In your State, you have no registration law. Registration alone is not the answer.

MR. McCAMMON: We have registration for professional engineers.

PROF. MIRGAIN: Is there a movement on foot to get one for surveyors?

MR. McCAMMON: No. They tried to get it through, but it was blocked before the last session in the House. I think the legal profession did more to hurt it than anything I know.

PROF. MIRGAIN: Is that activity backed by the engineers?

MR. McCAMMON: Of course, I don't know a great deal about it. I have only been there a year. I retired a year ago February. Most of my work is in the south-central part of the State, between Rutland and Bennington.

CHAIRMAN BAUER: Sometimes I wonder about that in the city of Cleveland where we have been going for a long time and theoretically and practically are in good shape. Still, I wonder, quite frequently, whether I am just not running my head up against a brick wall. I repeat, registration alone is not the answer. I am sure of that.

PROF. MIRGAIN: But it is a necessity. The type of registration is very important. I think there will have to be a legal definition and demarcation between engineer and property surveying. In the last JOURNAL there was a very interesting report of the Land Survey Committee of the National Council of State Boards Engineering Examiners, in which they did draw up the line of demarcation between engineering surveys and property surveys. The line of demarcation was the point at which the law of boundaries enters the picture.

MR. EDWARD V. COONAN (Baltimore, Md.): Mr. Chairman, recently in Maryland, we had no surveyor on the Board of Examiners. The surveyors combined and succeeded in getting someone on the Board recently. In making the change, they did, under this new law, define the difference between land and engineering surveying in this way. They provided, in this act, what would be the business of the land surveyor. Under the old law, a land surveyor could not do topography; he was simply con-

fined to property surveys. There is nothing in that, you know. One would starve to death if he couldn't do all the work the surveyor does in a metropolitan district. They provide certain things that the surveyor can do which practically cover all the work of surveying. That may be a good idea for some other states.

CHAIRMAN BAUER: The line of demarcation was that the land surveyor was the all-inclusive fellow and the engineering surveyor was the limited fellow, which is, I think, the intelligent solution. The engineering surveyor is limited to the lay-out of buildings and building structures. The engineering surveyor cannot do title or land surveying. The land surveyor can, however, do land surveying, topography, and the lay-out of engineering structures, etc. That, I think, is important. If you are ever going to have an act in Vermont, it would be wise to consider that particular phase.

MR. McCAMMON: The way I look at it is that a man up there has to pass a bar examination to practice law. He may be a very poor lawyer, but he has to pass some sort of examination. But the way it is now, anybody can come into the State, whether he knows the laws of land lines or anything else, and go right out and compete with you who have put in time and study. Naturally his prices are so ridiculously low that you wouldn't take a job for what he would take it.

CHAIRMAN BAUER: There we are getting into another field, of course. The answer to that, again, is a matter of education. Educate the man to do a proper job and the fees more or less take care of themselves.

MR. COONAN: May I tell you my experience in that business? All the big public service corporations in Maryland, the State Roads Commission, the government, and large corporations, have much of the surveying done in this way: They have a number of men in the field who are simply trained to take measurements. They don't do anything else. They have a number of men in the office that are trained to do drafting work. Each side knows its business, but neither knows the whole thing. That makes for a great deal of trouble.

Now, in Maryland, all these men have been given registration. It is very unfortunate that the man in the field can measure something and then not know what to do about it. They are all registered as surveyors. What do they do? These men go out and get private work on Saturdays and Sundays and at night. We call them "sundowners."

MR. McCAMMON: We have the same situation in Vermont.

MR. COONAN: It's all over the country, I assume. They do work for private industry and do it all wrong. If it could be arranged that a surveyor who is employed by any corporation or by the government could not do private work, it would solve that problem. I don't know whether that could be done or not.

CHAIRMAN BAUER: That is a very difficult problem, and it is current all across the country. The American Society of Civil Engineers, about 6 months ago, came out with a directors' report, after one of the quarterly meetings, in which it views the entire problem of part-time work in engineering. It sets up the criteria of proper and improper practice as a policy adopted by the American Society of Civil Engineers.

In the city of Cleveland, we have that situation in an exaggerated degree. During the war there was quite a bit of work, and there was a shortage of men. A large number of men working for the utility companies, the city, county, and state, and private offices, felt that it was their patriotic duty to go out and get what work they could, even if they had to do it on the time that they were supposed to be working for their employers. Now, of course, there isn't quite that much work, but those men are still being very patriotic and taking as much work as they can. The most unfortunate part is that, on the whole, the work is pretty bad.

I think our best course of procedure is this: First, to establish a policy of what is proper, and then to go to the governmental institutions and say, "This is the policy under which we are working. Do you agree or don't you?"

If they agree, it is relatively simple. We say, "We understand there are a number of violations. Don't you think you ought to issue an order to cease those violations?"

But I think the important thing is, first, to have a policy of propriety. I don't think we are ever on very sound ground to say, "Here, you must get out of the business, because you are competing with us."

We are not going to get much sympathy, even if we are justified in that position. But, as far as governmental employees working on government time and doing private work on government time, we are always on safe ground, both as taxpayers and as practitioners.

MR. WILLIAMS: We have had several cases of all those things in Michigan. I think the length of time that some of us have been in business shows that the fly-by-nighters—the attorney that comes in, or the engineer that is temporarily out of a job and decides to do some surveying—very soon defeat themselves. As far as government employees are concerned, we find that before very long some case will come into court, and it becomes very embaras-

sing for them to leave their offices during the day and appear in court to testify, especially if you prime the attorney on your side to ask them what time of day the job was done. We had one notorious case where a city engineer was doing subdivision work—using city men. That case was prosecuted by the city and the man was sent up for malfeasance. But, in general, I think the fly-by-nighter is a thorn in your flesh. He bothers you, he is a nuisance; but on the other hand, he does make you a lot of work.

MR. CAMMON: He does, eventually.

MR. WILLIAMS: And the jobs that he does take are the jobs, mostly, from people who want a cheap job. One is better off without them.

CHAIRMAN BAUER: I agree with what you say, except for this fact. Viewing it from the standpoint of a profession, rather than from our individual interests, I don't think the profession benefits by the black eye that it gets from bad work.

MR. WILLIAMS: That is true.

CHAIRMAN BAUER: I think we, as a profession, have a responsibility to protect the public from bad work.

MR. WILLIAMS: I might carry that a step further. We have a registration law, and we are policing that law right now. Within the last 2 weeks, two different parties have been informed that they are to cease and desist from the practices of land surveying in the State of Michigan. One city was warned that the so-called city engineer they were employing was not a registered engineer, and that they should employ someone else. They did.

CHAIRMAN BAUER: Who takes that authority?

MR. WILLIAMS: The Registration Board has an enforcement officer, and we simply furnish him with the evidence.

CHAIRMAN BAUER: In Ohio, our Registration Board prefers to be very neutral in such things, and leaves it to the Ohio Society of Professional Engineers to make such prosecutions. In Cleveland, we have made two prosecutions. In fact, we actually put one fellow in jail overnight. An injunction was granted to restrain him from practicing engineering, since he was not registered. The injunction entry cited specific violations of which he was guilty. He continued with those practices, and he then was cited for contempt of court.

MR. LUNDGREN: Mr. Chairman, prior to our registration—the grandfather's clause has just closed within the last couple of years—we had everybody and anybody surveying. We had realtors who would go out and get a plot of ground, set in a bunch of stakes with a cloth tape, and sign a certificate for recording as a surveyor. One man's attorney told him that there was no legal definition of a surveyor. The point of putting a certificate in, the attorney told him, was to identify the man who had staked out a plot or surveyed it. It wasn't a case of any legal procedure. So he proceeded to sign his plat and record it.

Now, we had a great many people of different capabilities, come in under that clause. We are still suffering from it. The most effective thing, I have found, is a complete certificate of survey. I find that the fly-by-nighter doesn't give a complete certificate; he doesn't state in his certificate what he did and how he did it. The most effective method that I have found is to put on the certificate that you surveyed the property for the purpose of so-and-so, that you did locate the monuments indicated and they were of such-and-such character, and that you made your survey under certain conditions. The more complete you make the certificate, the more valuable it is to the lawyer who examines that survey for title trouble. The older the certificate gets the more valuable it becomes, because it establishes monuments in existence at the date you made the survey. Many years afterwards, it becomes easier for surveyors to follow in your footsteps. But the fly-by-nighter doesn't want to put his name down on a specific survey telling what he did and how he did it.

CHAIRMAN BAUER: That particular point was one of the important matters discussed at the time we were drawing up the Technical Standards. That is why the Standards specifically say that every survey shall be accompanied by a plat of survey which tells the entire and full story of how the survey is made. I agree with you that the fly-by-nighter doesn't like to give a plat because it pins him down too closely.

MR. LUNDGREN: Not only the plat, but the certificate; the statement that he did so-and-so. That trips him.

CHAIRMAN BAUER: I don't know, however, if that obligates him legally. I have used the expression, "This survey was performed in full conformity with the standards of practice for property surveyors of the American Congress on Surveying and Mapping." I have found that is helpful.

MR. W. FOSTER: I am President of the Virginia Land Surveyors Association, a newly formed State Group. There is one thing I want to point out. If you take your car and haul passengers down the street, the police won't be long finding out and requiring you to have a license to carry passengers. Likewise, surveyors, before being issued business licenses, should be made to show that they are currently registered and paid up. If the individual, the developer, or the realty company were to require the person

doing the work to have a license, most of the fly-by-nighters would be lost, because in the majority of cases they don't have business licenses. If they are certified as surveyors or engineers and have it, they are just as entitled to practice as anyone else. It is a matter of educating the people to employ a legitimate surveyor, a man who is licensed to practice surveying by the Board of Examiners, and who has a business license to operate.

An attempt has been made in Virginia to require the license-issuing bureaus to have the surveyor show that he is certified. Also, the realty company is sticking its neck out by employing the services of a man that isn't properly licensed, either through the State Board or with a business license.

CHAIRMAN BAUER: Well, that business license is something new to me. I don't know exactly what value it has, except it is another charge that I don't think would deter any fellow who thought he was going to make some money on it. It is just another fee he has to pay.

I am inclined to think that the solution is more in the nature of a single registration of competency, proper competency. In addition to that, it is our job as a society to make our professional colleagues competent to handle the work they say they want to do. Now, that is unfortunately not always true. Our big job is education, but the educational process is not entirely one of just educating the ignorant. We all have a lot to learn. The whole matter of property surveying is moving along now, not so rapidly in new techniques as it is in new and more stringent requirements. Through the efforts of the title associations, title companies are operating more or less on the same basis, and they are getting more strict all the time. We, as property surveyors, must follow their practice. In the past, the smaller communities could say, "Well, we don't care how you operate in your locality; this is the way we operate." Sooner or later the larger title companies are going to say, "This is the way we want you to operate or we won't accept your survey." That is why it is very important for us, as a Division, to establish a pretty close connection with title men.

MR. WILLEY: In the case of Arlington County, Va., if you don't have the license to do land surveying, or any other professional work, you are open to fines, fees, and so on. You will have another enforcement agency on your neck. So it does help to insist that all people in the profession be licensed. That is strictly a county ordinance.

MR. FOSTER: There is no license required in the State of Virginia at all for a land surveyor except as each locality requires it. In the city of Richmond we are required to have a business license. In the majority of localities no license is required.

MR. CHARLES E. OFENSTEIN (Silver Spring, Md.): I think we might accomplish something the way Prince Georges County did in Maryland. It requires that all plats that go on record be sealed. We have one flagrant case in Prince Georges County of a man connected with one of the Government Agencies; I think it is the Bureau of Public Roads. He is handling a great deal of right-of-way work. Through his contact with the public in obtaining right-of-ways, he has obtained a great deal of survey work. But, he is not registered. He has put on, I think, some 25 or 27 plats over a period of possibly 10 years. But he has recently come up for registration, and the practice committee of the local society has been asked, by the Board in Maryland, to pass on his application for registration. We have cited the number of instances in which he has done work. Since the seal has been required, he has got whomever he can to seal the plats. He signs the plat and the man who puts on the seal also signs it. I know, personally, in two or three cases, that the man who signed the plat for him has got in trouble because he didn't undertake to check the plat. He simply took the surveyor's word for it that the plat was in proper order. The man still doesn't have his registration, and I don't think he is going to get it.

CHAIRMAN BAUER: What is the situation in Boston, Mr. Ullian?

MR. H. B. ULLIAN (Boston, Mass.): They have a surveyor's law, but one doesn't have to be registered. They are fighting it now, and I think a bill is coming up in the next session to make it compulsory.

MR. NEWELL B. SNOW (Buzzards Bay, Mass.): In Massachusetts, I think we have about 5,000 registered professional engineers and about 400 land surveyors, which is something like 75 percent of what we have there. There was an attempt, this year, to make it mandatory, but there wasn't enough agreement among all concerned. I guess it will be brought up in future years.

CHAIRMAN BAUER: Has it been shown that registration is preferable under your permissive act?

MR. SNOW: I can't see any advantage in keeping it permissive.

CHAIRMAN BAUER: I assume that the only advantage in passing any act on a permissive basis is that there is a certain advantage in being registered.

MR. SNOW: The only advantage in the beginning was that proponents were able to get

the act through on a permissive basis and probably couldn't have on a mandatory basis. Eventually, of course, it will be mandatory.

CHAIRMAN BAUER: Are there any other matters to discuss?

MR. E. J. KIRBY (Baltimore, Md.): We have a Maryland Society of Surveyors. I am the secretary. Some time ago, the State of Maryland let out surveys of the various pieces of property owned by it on the basis of competitive bids. We had a meeting with State officials and discussed the matter; then we received a letter from the State requesting us to give it some idea of what we wanted if we didn't want competitive bidding. I thought perhaps the Congress might be able to give us some advice on that.

CHAIRMAN BAUER: The last issue of the *Engineering News Record* has an editorial on that particular point in which it states that the matter of competitive bidding for engineering work is becoming quite important again. The editorial maintains that it is not sufficient to take the stand that you just don't want competitive bidding, because some men are going to bid anyway. It suggests that the American Society of Civil Engineers take some definite stand on the matter.

I merely point that out as a recent bit of news on the matter. The Congress has taken the position with the Veterans Administration as being opposed to competitive bidding. Because of the importance of the personal, educational, and experience elements involved in any professional service (which cannot be equated by any formula), price alone is no criterion. Professional men and services cannot properly be bought on that basis to the advantage of either the profession or the client. The Congress is officially in that position.

MR. ULLIAN: I think that a general council of some of the courts has ruled that surveying, not being a profession, can work on the bidding system. Now, we have done a lot of the work for the U. S. Army and they always called for bidding. But there is this ruling from this general council saying that, since surveying is not a profession, they would have to have bids.

CHAIRMAN BAUER: In that particular respect, there has been a battle going on for a year now which Secretary Dix, of the Congress, has spearheaded. It goes back to the fact that, in the census, surveyors are listed as semi-professional. We have been trying to have that changed and have made some progress. The Director of the Census Bureau has indicated sympathy toward the change. It hinges now on the question of the line of demarcation between, let us say, transitmen and actual engineers. I think something is going to be worked out on that basis. It seems to me it is more or less up to the local association to educate these agencies to another way of getting a fair price on a job. If any local agency wants the further backing of the American Congress on Surveying and Mapping, it can get it.

Because of the inability of any set of specifications to equate a man's knowledge, his background, and his understanding, competitive bidding cannot produce a fair basis of comparison.

MR. KIRBY: We expect to have a meeting Monday night on this subject. I would appreciate a statement, or perhaps you could work out some sort of program whereby we could present a certain plan to the Department of Public Improvements, similar to the one in Cleveland.

MR. COONAN: Mr. Chairman, a weakness of this whole proposition is politics. The man who has charge of the work is a politician, and he finds his friends. It doesn't make any difference whether one has a license or not; he gets the job. I read the Specifications Mr. Kirby was talking about, and those Specifications call for the most meticulous measurements imaginable. One has to do geodetic work to get them. That is all right. But they don't provide for any method of fixing the property lines. You can go out there and stick a stake in the ground and say, "This is a property line," and under those specifications they couldn't deny it. They do not provide for the location of the most important things there are about property surveys. That is the fault with the Standards that were set up by the Congress.

CHAIRMAN BAER: Except this. By inference, they indicate the degree of investigation that is necessary.

MR. COONAN: Of course, you and all the surveyors know perfectly well that in order to locate the property lines one has to have a title search. Those title searches are made by men who are professionally adapted to that work. Title people do it; lawyers do it; but surveyors don't do it. One might have a piece of property that has 10 or 15 different component parts and he would have to put those together. A surveyor can do that if he has the basic information which can be obtained only from the record.

CHAIRMAN BAUER: I don't quite follow you. Of course, each locality has its own method of operation. In our locality, the title company makes the examination. It is up to the surveyor to make his own title examination, if he will do it. We very often have to go back to the original owner and analyze the whole problem. We may have a tremendous lay-out of deeds and records and so on. Of course, we do have this advantage. We have very cooperative

title companies with very complete plants, and most of us who have been in business for some time have access to those records. But it *is* our obligation to make that investigation.

MR. COONAN: Well, when a settler came into Maryland, he complied with the traditions of the law of property. He could take up land from 50 to 2,000 acres. Now, how could he take it up? He had to get a surveyor. The surveyor would make his return to the land office where the business would be registered. But all the basic titles in Maryland are based upon the original surveys. Then, as the state became more and more settled and lawsuits came up about the regulation of these property lines, it became very important to know something about those property lines. One can't just go out on the ground and take whatever he finds, you know.

CHAIRMAN BAUER: Well, what do you have for a source of record? Don't you have those records available?

MR. COONAN: We have the finest set of records in the United States. They come from the beginning down to the present date. But to harmonize those descriptions and make them agree, you have got to know them. That is the point I am making. The surveyor should have a proper title search. If the proper title search doesn't give him what he wants, he can dig it up. Now, on these Standards there is nothing like that said about it. There should be something said about the determination of property lines.

CHAIRMAN BAUER: Before you came in, I did indicate that we are now in the process of expanding those Standards to greater detail, so that ultimately, if we ever finish the job, we will have a compendium or handbook on property surveying.

MR. COONAN: That is what we should have.

CHAIRMAN BAUER: It is going to be a difficult and long job.

MR. KIRBY: Doesn't the whole thing revolve around what constitutes a legal description? In other words, the survey should be based on the recorded descriptions, and some of those recorded descriptions do not have any metes-and-bounds descriptions in them. So when the lawyer turns the title over to you, he gives you the description of the property. From that point, the surveyor has to take over and follow the chain of title on back. Assume three parcels are recorded in certain books. They just mention the three parcels by acreage. You might have to go to three separate books to get the metes-and-bounds descriptions of each one of those pieces of property and then you don't know when it was surveyed. You might have to go back 75 years to find out when the property was subdivided from a larger tract.

MR. McCAMMON: That is the trouble in Vermont. After the first sale, there may be a hundred sales, and the lawyers do not want any descriptions because that takes away their title searches.

CHAIRMAN BAUER: That is one of the most important functions of the property surveyor—to clear up those old deeds and ambiguous descriptions and make sound descriptions out of them. That is a very valuable service that the surveyor can perform for the owner—to get these descriptions down to where they should be. Of course, he can best perform that service if he gets in ahead of the sale. If he gets in after the sale, then it is his job to try to convince the attorney or the owner that it is worth while making the change.

MR. KIRBY: I have had quite a few jobs turned over to me where the lawyer has a client, and the title company won't pass the job because there are several descriptions with some exceptions. So it has come to the point where he doesn't know whether he is minus or plus with his acreage. The title company says it must have a survey. The lawyer calls me up and says, "You have 3 acres to survey in Hartford County." He tells me the 3 acres are part of a 30-acre tract, with four exceptions, and then what is left of it is the parcel to be surveyed. So I have to make a survey of 30 acres, survey all the exceptions in the tract, and take what is left over for my 3 acres.

CHAIRMAN BAUER: The answer to that is: don't give a price in advance.

MR. KIRBY: Well, the whole problem is based upon the different viewpoints. In other words, the lawyer has the viewpoint that he merely tries to find out whether the property is clear and not encumbered, and merely tries to get a description that will transfer that property from one man to the other. He doesn't care what the monuments are or anything else. That is the surveying job, but it is a job that is not recognized. The lawyers have surveys made only when a piece of property becomes so involved that it is absolutely necessary to have a survey. In other words, only when they have trouble do they have a survey made.

CHAIRMAN BAUER: That is part of your educational job—to show the importance of a survey with every transaction.

MR. W. H. PRIMROSE: I wish we could find out how to educate those people. What you said a minute ago is my creed in life: If you get something snarled up, stick with it and straighten it out. But who pays the bill? Here is a concrete example: The lawyer asks me if I am ready to do a rush job. He is very

friendly and complimentary. The job only amounts to an acre and a half. He wants to divide the remains of an 11-acre parcel. I say, "We will get right to it." He does not ask for a price. That is Friday; the settlement will be on Wednesday. I say, "I can't promise anything." We normally would consider it a $40 job,—225-foot frontage and 285-foot depth. But it actually took 7 days to find that piece of property. I called him twice to tell him why we were delayed—that we were working on the job and that is was very involved. He said, "All right, go ahead." When I did get control, I called him and told him we were ready to go, but that my advice would be to get the 11 acres straightened out. When I gave him the price of straightening the thing up, that is the last I heard of the deal. So I don't know where we stand now. I don't think any man alive can tell, within a reasonable limit, what it will cost to do any outlining, regardless of where it is.

CHAIRMAN BAUER: Even in city work, I find I am less able to judge prices as each year goes by. Our conditions are getting more complicated. Certainly traffic conditions are getting far more complicated, and we are losing rather than gaining monuments.

MR. PRIMROSE: I need help in the education problem. If I don't get them educated, I am going to go broke.

CHAIRMAN BAUER: It is a difficult job for one man to do the educating.

MR. PRIMROSE: I mean, it applies whether it is wide-open or competitive bidding. The first question is, "How much is it going to cost?" And I have to tell them that I don't know how much it will cost.

MR McCAMMON: Do you have a per diem rate?

MR. PRIMROSE: Yes, $55 a day. But very few want to hear about that.

MR. KIRBY: If you tell them it is $55 a day, they ask how many day it will take, and it is the same thing all over.

CHAIRMAN BAUER: I sometimes ask, "Must you have this job done?" and, if he says he does, then I say, "All right, we will go ahead and do it. If you don't have to have it done, forget about the whole thing." Sometimes that is effective and sometimes it is not.

MR. PRIMROSE: Sometimes they say, "I can get that done for $20 or $25." I say, "That is your prerogative."

MR. KIRBY: And then somebody does it.

MR. OFENSTEIN: What are you going to do about a case like this? One of the title companies right here in town called our office and said they had to have a survey on a certain piece of property far out in the country, about 2 acres. The house was probably worth about $4,000. But they had to have a certified survey on it for title insurance. It cost us $1,200 to make that survey. There were three erroneous surveys on the property, and there were original corners called for and original deeds still in existence. It was very easy to prove the survey was erroneous. But we had to survey a 600-acre tract in order to get the 2 acres out of it. The title company said that was too much money: "We will pay you $400." Yet they required the certified survey.

CHAIRMAN BAUER: One of the very large insurance companies had me do a job that cost $750 in salaries, for which finally, after much persuasion, they paid me $150. I have no answer for that problem.

MR. OFENSTEIN: But the point is this. There is a title company that recognized and cooperated in making the survey. They recognized the value and necessity of it. Yet they told the client that $400 was all it was worth.

CHAIRMAN BAUER: Well, it merely proves that we are living in a world that isn't entirely fair. Beyond that, I don't think we can reach any conclusions.

MR. PRIMROSE: It is all a matter of education.

MR. KIRBY: Don't you think the whole thing revolves around the fact that the legal description is a document that determines the work? We are making specifications up against ourselves. In other words, we are trying to raise our work as surveyors, but the legal document on record that we work from still isn't raised up anywhere near our standards.

CHAIRMAN BAUER: It is our job to raise it.

MR. KIRBY: Don't you think we should go to the lawyers and title companies, to the ones that transfer the titles, and bring them up to where we are now?

CHAIRMAN BAUER: Yes, by pointing out the weaknesses of their own descriptions.

MR. KIRBY: But that is going to cost them money and also they don't care particularly about the metes-and-bounds description as long as that property will transfer from one man to the other.

CHAIRMAN BAUER: They will, after they take a few lickings. Again, it is an educational problem. Telling them once or twice is not going to convince them. But they will be convinced by repetitions over an extended period, by several men. It is a slow job.

MR. KIRBY: The work of the surveyor comes directly from the lawyers. It comes from what the lawyers write in the deed and put in the record.

MR. McCAMMON: I think we ought to get the lawyers to join the association.

CHAIRMAN BAUER: Relatively few of our descriptions are drawn by lawyers; most of them are drawn by engineers or the title company.

MR. KIRBY: I mean the document that transfers the property. The description is just one particular part of that deed. When we write a description, we write one specific description to be incorporated in a deed for the transfer of property. We write one description out of a thousand that is transferred without a surveyor having written it—merely a transfer of a description that was written previously. Sometimes it is an assemblage of descriptions that are mentioned in that deed merely by book and page number.

CHAIRMAN BAUER: By education you ultimately convince one or two and then more of the fact that a description of that kind is unsatisfactory.

MR. KIRBY: We are continually raising the specifications of the surveyors. The ones we should go after are those lawyers and title companies who have descriptions written up and have surveyors make them a part of the deed itself. If that is in there, you are pretty well fixed.

CHAIRMAN BAUER: There have been suggestions that every survey be recorded. Years ago that was done in our county somewhat unofficially. A survey was filed, not with the county recorder, but in the county map office, where it was available to all.

MR. McCAMMON: How many states have a law requiring guarantee of title? We don't have it in Vermont.

CHAIRMAN BAUER: I don't think any state requires a guarantee of title. I think that is merely a matter of local practice.

MR. McCAMMON: You have a title company out there that searches titles. We have none in Vermont that I know of. It is all handled by the lawyer. The lawyer writes the deed and it is recorded, of course, in the city clerk's office. We don't have abstract companies either. The attorneys have the abstract. That is the reason they don't want a law requiring that a plat be submitted with every deed.

MR. PRIMROSE: There is a question of title companies guaranteeing title to your property and guaranteeing absolutely nothing about where it is.

CHAIRMAN BAUER: Title insurance primarily guarantees the paper part of the transaction only. It is your job as a surveyor to make that paper mean something on the ground. That is a distinction that too few owners know. An owner called me up recently to find for the first time that her title paper did not guarantee her boundary locations or dimensions. She thought there should be a law passed about it. I told her that it would please surveyors very well if there were a law that every property had to be surveyed, but the profession could not propose it. She said, "How was I to know that the paper didn't mean that I actually owned what the salesman showed me?"

My answer was, "I don't want to place too much blame on you, but I am pretty sure that, if you went to the grocery and ordered 5 pounds of potatoes, you would look at the scale to see that you got 5 pounds. But when you buy a piece of property for $25,000, you pay no attention to the accuracy of your purchase."

If there is no further discussion, the meeting is adjourned.

(The meeting adjourned at 12 o'clock.)

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Michigan Society of Registered Land Surveyors

THE Officers and Directors of the American Congress on Surveying and Mapping take great pleasure in announcing that the Michigan Society of Registered Land Surveyors has joined with us as an Institutional Member. This is the second professional surveyor group to join the Congress as a body in the pursuit of mutual objectives and we welcome them heartily and sincerely.

Surveying Instruments Division

EDITOR'S NOTE.—The Technical Division on Surveying Instruments convened at the Ninth Annual Meeting of the American Congress on Surveying and Mapping on June 9, 1949, in the District Room of the Hotel Statler. Mr. L. C. Higbee, of W. & L. E. Gurley, Troy, N. Y., Chairman of the Division, presided.

CHAIRMAN HIGBEE: It is nice to welcome so many of you to this Technical Session on Surveying Instruments.

I was, for a number of years, secretary of a charitable organization, in which I always recorded, "The Chairman opened the meeting with appropriate remarks." You can all make those appropriate remarks perhaps better than I can, so we will consider them made. Because we are about 15 minutes late getting started, we will go right to the first speaker. We tried to prepare a program for this meeting which would embrace the progress that is being made by the military forces, the demands of civilians, and some of the viewpoints of various instrument makers. These groups represent a cross section of this Congress.

The first speaker will present the Army viewpoint, and his topic will be "The Automatic Traverse Computer." It will be presented by Mr. C. W. Kitchens, of the Engineer Research and Development Laboratories, Fort Belvoir, Va.

The Automatic Traverse Computer

By C. W. KITCHENS
PROJECT ENGINEER, ENGINEER RESEARCH & DEVELOPMENT LABORATORIES, FORT BELVOIR, VA.

IN 1946, the Corps of Engineers was requested by Army Field Forces to develop a computer which could solve the traverse problem automatically. The computer was to be electro-mechanical or electronic and was to have the sine and cosine functions built in. The project was assigned to the Ground Control Branch, Technical Department V, Engineer Research and Development Laboratories, Fort Belvoir, Va. Actual development of the machine was made by the International Business Machines Corporation (IBM).

Before work was started, a complete review was made of existing computing machines of both United States and foreign origin. All types were carefully examined, ranging from the standard issue calculator used in the field to the more complex *Eniac*, or IBM Selective Sequence Electronic Calculator.

The British Twin Marchant and German Brunsviga special calculators presented possibilities. Each consists of two single units (sine and cosine) mounted and controlled by one shaft. Both machines operate from the single shaft and are capable of computing both coordinates at the same time. The sine and cosine values, however, must be taken from a set of tables, each inserted in the proper field, and then multiplied by the distance. The fact that manual control and the

use of tables are required to perform the computation influenced the decision to seek some automatic method. The studies which followed included an investigation of an electronic type computer. The consensus of opinion of the experts was not encouraging. They felt that manufacture of a machine which would meet the current Department of the Army "military characteristics" in respect to size, weight, and mobility for field use, was probably premature by 5 to 10 years.

Having completed this initial investigation—the 12 leading manufacturers of computing machines were consulted—and despite the pessimism of its contemporaries, IBM confidently undertook to design a computer that would most nearly meet the "military characteristics."

DESCRIPTION

The Automatic Traverse Computer is the result. This consists of a specially designed combination of electric calculating units and a modified IBM electric typewriter, compactly arranged in a mobile desk-size unit. The cabinet containing the computing units is only 27 inches high, 41 inches long, and 20 inches wide. There is ample leg room for an operator. The total weight of the first model is approximately 750 pounds but the manufacturer indicates that the weight of the second model will be reduced by as much as 250 pounds.

The electric typewriter is connected by a cable and two plugs. It may be placed on the cabinet itself or at any convenient operating point remote from the computing unit; the distance is limited only by the length of the cable. The electric power required for operating the computer and typewriter is approximately 10 amperes at 110 volts AC.

By means of a selector switch mounted on the right side of the typewriter, the machine can be adjusted to make the type of calculation required. Sine and cosine functions, automatic computation of traverse problems, addition and subtraction, and multiplication and division, are the four basic functions.

OPERATING PROCEDURE

For actual computations of any traverse problem, procedure is relatively simple.

A computation form, or problem sheet, is placed in the typewriter carriage and aligned to the desired field by operation of the tab key. The selector dial is then set to the type of calculation desired. The first given amount (azimuth) of the problem is keyed on the computer keyboard, digit by digit. The typewriter responds instantly by writing on the form each number as it is keyed, thus permitting errors to be corrected before they reach the computer. Depression of the motor bar registers the azimuth in the computer, initiates the automatic computing procedure, and releases the keyboard for handling the next factor of the problem, the distance.

Depression of the motor bar after keying the second factor registers the distance, and the computer automatically completes the calculation of the legs of the triangle. The results are immediately printed and the typewriter carriage automatically returns to the initial position of the next line.

A space key serves to maintain proper placement of amounts within the designated fields on the problem form. *Subtract, Total, Error, Clear,* and *Stop* keys are provided and an interlock system prevents improper manipulation of the controls while the computer is in use.

The *Subtract* key is used only on addition and subtraction problems and must be operated before entering the value to be subtracted. It sets up a circuit which causes the readback from relay storage to energize the minus solenoid and print a minus sign. It also sets up circuits which will cause the set up amount to be subtracted.

The *Total* key serves two functions. On *Add* it is pressed to read out the total alue in the counter at that time. Through an interlocking device, it will not read out a total after the clear key has been depressed unless an entry has been made. On *Traverse Problems* it is "alive" only after the angle has been entered and during the first position of second entry, at which time it picks up a relay to read out the cosine and sine of the angle.

The key marked *Error* has the one function of restoring the relay storage counters to zero. The only time it is of use to the operator is when an error has been made in an entry prior to the operation of the motor bar. It will not "erase" what has been put in storage after the motor bar has been struck because in the first calculator cycle, the data have been read from storage into the counters and the error key will not remove that data.

The *Clear* key serves to clear the typewriter and calculator of all conditions brought about by inserting a problem. It restores the machine to normal and prepares it to start a problem over again or to shift to start a different type of problem. Before clearing, it is necessary either to let the machine complete its normal sequence or to depress the stop key to stop the calculator.

The *Stop* key is provided to halt the computer in case of emergency. It will hold the calculator during a calculating cycle and will hold the typewriter while it is typing out counters. At the same time it will unlock the computer keyboard. After this key has been depressed, computing may be resumed by striking the motor bar or the machine may be cleared for a new problem by pushing the clear key.

The typewriter may be used in the conventional manner in addition to its main function as a recorder of problems and answers. The keyboard has been modified to provide certain special characters (triangulation station, bench mark, stadia station, plus, minus, division, and equals signs) pertaining to the special type of calculation performed or required in related texts for typing field descriptions, notes, etc.

The computer is capable of forming 6-place sine and cosine functions of angles (degrees, minutes, and single seconds) from 0° to 360°, and the automatic computation of the traverse problem where the azimuth and distance are entered through the electromatic typewriter. The computer determines the cosine and sine value of the azimuth entered, stores this value in counters, multiplies it by the distance, and records the value of $\triangle Y$ and $\triangle X$ on the form along with a plus or minus sign, depending on which quadrant the azimuth is in. It also carries a running total of *northings* and *eastings* of each station. It will add, subtract, multiply, and divide. Any of these operations may be executed independently under normal control or in combination in a predetermined order, as directed by the automatic sequencing device.

TRAVERSE COMPUTATION

In traverse computation, azimuth angle and distances are the known or given factors. The problem is to compute latitude and departure, by multiplying the distance by the cosine and the sine of the azimuth, and to accumulate northings and eastings. The latter two are to be stored for use in subsequent computation. The angle is given in degrees, minutes, and seconds, and distance is given in units of distance up to 9999.99. The degree of accuracy in the answers is equivalent to that derived from the use of a 6-place table of natural functions. Latitude and departure are computed as 6-digit, rounded figures; northings and eastings are accumulated as 10-digit figures. The net machine

time, for computing only, is a maximum of 10 seconds.

In computing only sine and cosine of azimuths entered, as in traverse computation, with degrees of accuracy the same, both functions are produced at all times. Answers are given as 6-digit numbers in the net machine computing time of 7.2 seconds.

The machine will handle addition of positive and negative numbers up to 10 digits and 9 digits, respectively. Totals are given as 10- and 9-digit numbers, and the net machine computing time is ¼ second.

In multiplication operations, 6-digit multiplicands and 6-digit multipliers yield 12-digit products. The net machine computing time is a maximum of 1.8 seconds.

When dividing, a 10-digit dividend may be divided by a 6-digit divisor to produce an 8-digit rounded quotient at an average speed of 12.1 seconds.

In addition, multiplication, and division, the amounts may be written in any one of several fields, and a variety of arrangements is possible without having to change the tab key setting.

The left front portion of the stationary frame houses a small relay gate under which are mounted two stepping switches. The stepping switches are identical in construction. The stepping switch nearest the hinge is operated only when data are being put into the computer by the typewriter. Its purpose is to control and interlock the typewriter to the computer during typing in of data, stepping one position for each character entered. The other stepping switch serves the same purpose for typing data out of the computer in that it interlocks the two units, stepping one step for each digit typed out.

When an angle up to 360° is entered into the computer, it is first changed to its equivalent angle of 45° or less. At the same time the signs of the cosine and the sine are determined for that quadrant and stored within the computer.

The angle of 45° or less is looked up in three stages of the *table look up unit*, selected in relation to the tens of degrees, units of degrees, and tens of minutes with interpolation of units of minutes, tens and units of seconds. When the proper value of the angle is found in the *table look up unit*, 10 digits are read out, the first 6 being the function of the angle and the last 4 the difference for interpolation.

All three *table look up stages* are clutch driven. The first and second stages consist of one unit each, while the third stage consists of six individually clutched units operated in unison. The first stage represents tens of degrees. The second stage represents tens of minutes. The third stage represents the units of degrees. It consists of six clutch-driven units, each containing 50 levels. The 300 commons of the levels of this stage are connected to the terminals of the second stage. Of these 300 levels, only 10 are selected at a time.

Since units of degrees consist of 10 possible selections, and the levels have 20 positions, the sine and cosine are both looked up on the third stage. Due to the cosine being used first in a grid traverse problem, the first 10 positions contain the function of the cosine for the value set up in the three stages. By advancing the third stage only 10 positions, the sine of the same angle may be read out.

The units of minutes, tens and units of seconds are converted to tenths of tens of degrees and multiplied by the difference of function (four decimal places) as taken out of the *table look up* for the value. The units of minutes are entered directly into right hand components counter as tenths of tens of degrees. The numerical value of seconds is placed in the multiplier counter, and is converted to tenths of units of minutes by dividing by 60 or multiplying by 0.01667. In this

case it is multiplied by 0.01667 with the value 1667 entered into the multiplicand counter. Since the value of units of degrees has been entered in right hand components counter during multiplication, it is carried into left hand components counter, and the resultant of this and multiplication are again fed to the multiplier counters. By placing the difference of cosine, then sine into the multiplicand counter and multiplying each, adding the resultant to the function of the cosine and sine respectively, interpolation has been completed and the angle functions are stored for later use.

The calculating unit of the computer is made up of standard IBM machine devices, such as counters and relays, and other parts identical to those employed in the IBM Automatic Sequence Controlled Calculator built for, and presented to, Harvard University. The trigonometric function-forming apparatus, however, is of entirely new design and is a development of distinct advance in terms of compactness, accuracy, and speed.

SPEED OF OPERATION

It is not essential that personnel be given weeks of instruction to operate the IBM calculator satisfactorily. Personnel from the Army Map Service, Washington, D. C., who were given only 30 minutes of basic instruction in its operation were able to compute traverse problems comprising 606 courses in 240 minutes, or an average of 2.525 courses per minute. A typical traverse problem computed in the usual manner requires approximately 24 minutes for 10 courses, or an average of 0.416 courses per minute. The comparison of the two methods shows that the IBM calculator is better than 6 times faster than the normal method, though an individual computing the problem by the usual method cannot continue at even that pace. A trained computer can average 100 to 125 courses during an 8-hour day and, on this assumption, the IBM calculator will do the work of 9 or 10 men on this type problem.

The computer will be mounted in a mobile survey van, along with two-way radio communication, field telephone, drawing board, file cabinet, auxiliary computer, and other necessary equipment as determined by engineering tests now being conducted in the vicinity of Fort Belvoir, Va. Upon completion of these tests, the unit will be made available to Engineer Troops on maneuvers for service testing.

During service testing the computing unit will operate as the base unit in conjunction with several survey parties. The survey parties will be in direct contact with the unit by radio at all times, and their data transmitted to it. Final evaluation of this unit will depend upon final results of the service test information.

MODIFICATIONS FOR ADDITIONAL USE

Examination and testing of this computer have indicated that such equipment might be used advantageously in other types of problems, such as performing the inverse problem automatically. Given the coordinates of two points, the automatic solution of the azimuth and distance between them is desirable. This would require the automatic trigonometric functions of tangent and cotangent. Inquiries regarding this modification reveal that the over-all size and weight would be increased approximately 30 percent.

Another requirement for solving different type problems is that the banks for each function (addition, subtraction, multiplication, and division) be enlarged 2 to 4 digits each. The 6-digit sine and cosine functions as contained in the present experimental computer should be enlarged to 8 digits. This would permit

computation of first- and second-order triangulation problems.

Engineering tests performed to date indicate that this computer is accurate, stable in adjustment, compact, and meets the military requirements for which it was designed.

As was expected, some minor weaknesses and desirable modifications were uncovered during the tests of the first pilot model. The manufacturer is to be complimented, however, for adding another fine instrument to the American market and for producing the first computer of this type in the world.

One of the major objectives at the Engineer Research and Development Laboratories is to work with our manufacturers and Government agencies to provide the best item possible to meet the requirements as established by the armed forces.

CHAIRMAN HIGBEE: Thank you, Mr. Kitchens. Are there any questions? If not, we will proceed to the next speaker, who is likewise a Project Engineer at Fort Belvoir. He is Mr. J. J. Durkin, who will talk on "Military Problems in Development of Surveying Equipment."

Military Problems in Development of Surveying Equipment

By JOHN J. DURKIN

PROJECT ENGINEER, ENGINEER RESEARCH AND DEVELOPMENT LABORATORIES, FORT BELVOIR, VA.

AS A RESULT of the past war, and the increasing influence of science on modern warfare, the Armed Forces are more conscious than ever before of the necessity for continued active research and development in all fields applicable to military operations. It is generally acknowledged that the security of the country might well depend upon the development of military equipment, techniques, and methods of application superior in all respects to that of any possible enemy. Although no one ever wins a battle directly with a surveying instrument, this is as applicable to surveying equipment as it is in other fields.

The Ground Control Branch of the Engineer Research and Development Laboratories, Fort Belvoir, Va., is responsible for accomplishing research and development in the field of surveying equipment for the Army and undertakes work in this field as directed by the Chief of Engineers. The basic principle of most surveying equipment has been long established. The work of the Ground Control Branch, therefore, consists of the development of new types of equipment and of domestic sources of supply. Other developments include the re-design and modification of existing equipment, the evaluation and adaptation of commercial equipment to military uses, and the evolution of techniques for the most efficient employment of such equipment in accomplishing military surveys. The Branch also proposes the initiation of projects for development of instruments, to furnish the military surveyor the best possible equipment for accomplishing his mission under all conditions. To accomplish this research and development mission, the Ground Control Branch must keep abreast of current developments in other fields affecting survey equipment, since such new developments frequently create problems.

Problems are numerous, and in most instances are of such nature that the civilian engineer is not overly concerned

with them. They are peculiar to the military primarily because of the scope of possible military operations involving transportation, supply, and personnel, and not because of a general employment of techniques differing from those of the civilian engineer. The fact that any military operation may take place at any place in the world makes it mandatory that all surveying equipment be capable of efficient operation in variable conditions. Surveying under combat conditions necessitates concealment from enemy observations and minimum exposure to enemy fire. Adequate protection from shock, weather, and salt water must be given instruments and equipment during transportation. The problems of supply are almost beyond the comprehension of those inexperienced in such operations. The comparatively inexperienced status of personnel employed in military surveys creates a necessity for simplicity of equipment and standardization of methods seldom considered in civilian surveying. These factors have created a number of characteristics that must be included in every piece of surveying equipment standardized for use by the Army. Some of the modifications made in instruments and equipment, and the factors influencing these changes are described in the following paragraphs.

EXTREME TEMPERATURES

Ability to withstand high and low temperatures is required in surveying equipment, not only to provide for its efficient operation in the wide range of temperatures throughout the world, but also to insure that it is not damaged in storage or shipping. Operation and storage are dealt with separately. An operational range of $-65°$ to $+125°$, between which the equipment must be capable of efficient operation, has been set up. This temperature range approaches the limits at which it is believed possible for an operator to work and the problems are primarily in bearing surfaces, tolerances, and greases. However, when heavy gloves or mittens must be worn by the operator, a problem is presented in designing equipment to permit such operation, or designing attachments for certain component parts of the equipment, that will enable the operator to accomplish the necessary movements of such parts in operation.

The design of the eyepiece for low temperature operation is particularly important. If the eyepiece is of uncovered metal, there is a possibility of it sticking to the operator's eyelid or face. If the eyepiece shield is flat, with the back lens near the surface, the heat from the observer's eye will cause frost on the lens. To prevent these possibilities, the design of many conventional eyepieces must be changed, or attachments designed.

Under conditions of storage and shipment, equipment must be capable of withstanding, without damage, storage at temperatures ranging from $-80°$ to $+160°$. The problem here extends to many materials (particularly plastics) and parts such as level vials and optics.

FUNGUS PROTECTION

Operations in the Pacific during the past war demonstrated clearly the necessity for fungus protection of equipment, particularly optical instruments. The optics of instruments were rendered useless by fungus growths in a comparatively short time. Equipment can be protected from fungus by proper care, and the problem of such protection would then seem to be one of educating personnel. However, because of the peculiar nature of military operations, facilities for such care are often not available. In addition, such care is impracticable when equipment is in storage, particularly the storage facilities available during active operations, when equipment is left on the ground covered with a tarpaulin for several days. Such storage

conditions in tropical climates are ideally suited for the start of fungus growths. A method of protection that will keep the fungi from reaching the equipment, or that will kill the parasites around critical parts of the equipment, must be utilized. If equipment could be sealed in a container before shipment from the factory, it would be protected from fungus attacks. Once opened in the field, however, it would be unprotected, since re-sealing under conditions of high humidity requires elaborate equipment to be effective. It may be necessary to resort to some partially effective method temporarily. However, it seems assured that some feasible method of protecting the critical parts of equipment by an agent that will kill the fungus parasite without danger to the operator will eventually be worked out. Some promising results have been obtained by the use of radium foil, and the over-all problem is still under consideration.

DUST PROTECTION

Reports from theaters of operations early in the last war indicated that certain equipment, particularly transits, was inadequately protected from damage by dust. Sustained operations under severe dust conditions, when the nature of the operation prohibits frequent and careful cleaning, soon cause severe damage to circles, verniers, and other parts. This is one of the reasons for recommendations that the Army develop an optical-reading instrument. The optical-reading instrument, properly designed, affords almost complete protection from dust damage to all critical parts. Once current developments are completed in this field, and the optical-reading instrument standardized for military use, the problem of dust protection for military surveying equipment will be, for the most part, solved.

MOISTURE PROOFING

Moisture proofing is a problem somewhat similar to dust protection. The nature of military operations frequently necessitates the use of surveying equipment under extremely adverse conditions. Considerable time may elapse after use before the military surveyor has an opportunity for cleaning and caring for his equipment, thus it is mandatory that all possible protection against moisture damage be provided. The frequent use of equipment during exposure to salt water spray and salt-laden air causes extensive damage from corrosive action. This damage is particularly notable on the circles of conventional type transits, and exposure is at least partially responsible for the chipping and peeling of paints and finishes. Foreign-made optical-reading instruments in use by the armed forces apparently have been less subject to such damage, according to reports from the field. It is believed that our program of developing optical-reading instruments will result in elimination of corrosion damage.

COMPACTNESS

For efficiency in handling, transporting, and storage, compactness is desirable, and always considered in any development. In general, however, surveying equipment does not lend itself to substantial reductions in size without loss of other, more desirable, features. The policy in the past has been not to sacrifice efficient features of the equipment for the sake of saving a few cubic inches of space. However, the increased importance and use of air transport in military operations may cause this problem to assume increased importance.

RUGGEDNESS

The likelihood of rough treatment during active military operations is the principal factor in requiring ruggedness, and ability to withstand severe shocks, in all surveying equipment. Simply marking a shipping container "Delicate

Instruments'' does not insure careful handling in such an operation; therefore the equipment must be capable of withstanding appreciable tossing around and yet remain operable. There is always the probability during an operation that piers and docks will not be available, and that equipment will be put ashore from a beached ship, or lightered in by small craft or barges. Equipment is often subjected to thorough drenching from spray, and occasionally subjected to complete submersion. Certain equipment is severely damaged during such operations, if inadequately protected, and often completely ruined. Fortunately a large part of the surveying equipment is of a type that is not seriously damaged by such exposure, provided it can be cared for within a reasonable length of time.

An additional, though less important, reason for ruggedness in surveying equipment, is the handling and manipulation given it by inexperienced personnel during actual operation. For the most part, military survey personnel have not the experience required for the ''know-how'' and the ''feel'' in using instruments. Consequently tangent screws, clamping screws, adjusting screws, and similar parts must be capable of absorbing considerably more than normal punishment without damage. Most of the requirements of such ruggedness in instruments will be incorporated during the development of well-designed optical-reading instruments, carrying cases, and transporting cases. Tests and reports from theaters of operation indicate that foreign-made optical-reading instruments are more rugged than conventional transits, and that these instruments suffer little damage from rough handling or shipment.

WEIGHT

The use of lightweight metals in the construction of equipment is worthy of consideration from the standpoint of transportation and actual operations in the field. Substituting lightweight metals in one small item is, of course, insignificant, but when it is multiplied by the hundreds of items required to equip a single survey company, the saving in weight becomes an appreciable factor. When a ton can be eliminated from a single item as, for example, the Bilby Tower, the saving becomes substantial. This is particularly true in view of the possible increased utilization of air transportation. Advantages of lightweight equipment are desirable to both military and civilian surveyors. No one likes to carry an instrument weighing 20 pounds when one weighing 10 pounds is equally efficient.

OPERATION

Simplicity in operation of surveying equipment used by the Military Forces is important because of inexperienced personnel and the relatively short time that can be allocated for their training. It is impracticable to tie up personnel in training for a period of 2 years, or even 1 year, during wartime, and it is equally impracticable to train a sufficient number during peacetime. This is because of limitations on the size of the Armed Forces and the fact that the well-trained peacetime surveyor is quickly advanced to a more responsible position during wartime. It is necessary to simplify equipment and methods of application to the utmost so that a person of average intelligence can be quickly trained to use the equipment and secure the required results. During the past war, the period allocated for training a surveyor in the Corps of Engineers was approximately 12 weeks, part of which was devoted to other military training. At the completion of this period of training, he was expected to take over the job of instrumentman in a survey unit on a full-time status. He seldom remained in such a job long enough to become truly experienced, because he was pushed into a more

responsible job because of the rapid turnover of personnel in military operation. There seems to be little possibility of any great progress in the problem of simplification of surveying equipment, since such equipment is as simple as other requirements will permit. The tilting-telescope level, the optical-reading theodolite, and the three-screw leveling base are some features that tend to simplify operation of equipment. Use of stools, or bucks, in taping lines of third-order accuracy, or above, has simplified distance measurements, and the recent development of the Survey Computer has certainly simplified the computation of the traverse problem. Radio has simplified the application of many survey methods, by permitting an experienced surveyor to control and advise numerous field parties, and to check their work while they are still on the site of the survey.

CONCEALMENT

The problem of concealment during combat must be considered in all surveying equipment. Improvements in night-illuminated transits is a direct result of this necessity. Radio-active luminous material on level vials, which permits leveling of the instrument without the use of a flashlight or similar light source, is another improvement. The optical-reading instrument meets night-concealment requirements in its basic design. Certain types of surveying equipment, such as signal lamps, targets, and subtense bars are, of course, objectively visible. There is little that can be accomplished toward concealment of this equipment, except to restrict the field of visibility of the emitted light. This will be considered in improvements of such equipment.

STANDARDIZATION

Perhaps the greatest problem of all from a military viewpoint—and the least from a civilian viewpoint—is that of standardization. Numerous items of equipment are immobilized indefinitely in every military operation because of a lack of proper spare parts. The stocking of such spare parts, with surveying equipment in its present state of standardization, is an almost impossible task. The Armed Forces presently uses several types of levels, transits, alidades, etc., made by at least five different companies, plus several foreign-made instruments. Less than 5 percent of the total parts used in these instruments are interchangeable among instruments of similar types. To stock sufficient spare parts to assure a supply for all types of instruments and equipment would require more space and personnel than could ever be made available. It is seldom possible to take the target made by one manufacturer and use it on a rod made by another. Not many months ago a topographic unit in an overseas theater drew a number of instruments, together with tripods, from the Engineer Depot in that locality. When these instruments were issued to the troops for use in the field, it was found that only 2 out of 10 of the same type instruments would fit the tripods furnished, in spite of the fact that the tripods and instruments were made by the same manufacturer. Tripods to fit 8 instruments were not available in the local Engineer Depot. Such incidents are not a rarity. As long as the present status of standardization is maintained, any program of providing an adequate source of spare and replacement parts is doomed to failure, and the allocation of a qualified instrument repairman to survey units is of questionable value. This is a difficult problem to solve, since the Military Forces, insofar as possible, procure commercial equipment. Each manufacturer has his machinery set up for making each part of his particular instruments, and is reluctant to make expensive changes, and he justly believes that his instruments

have certain merits not found in his competitors'. These difficulties of solution, however, do not lessen the desirability of a thorough and effective program of standardization. The ideal state of standardization, from the military viewpoint, is to have every possible component part of every instrument, and all accessories, interchangeable. A single tangent screw could serve for all instruments, from an alidade to a theodolite; level vials, of possibly four stages of sensitivity, all with the same outside dimensions, could meet the requirements of all instruments; all instruments should fit a common tripod; reticles should be interchangeable in all instruments; and a single clamping screw could be designed for all instruments. These are just a few pertinent examples of how far such standardization could easily go, and it is hoped that some progress will be made in this direction within the next few years. The Ground Control Branch currently has a project to develop a universal tripod for practically all military surveying equipment, and consideration will be given to standardization in all future projects.

In addition to these briefly discussed problems, the military forces are vitally interested in any modification, development, improvement, or application of surveying equipment that tends to speed up the accomplishment of control surveys, without loss of required accuracies. The fast movement of offensive troops in modern warfare has required a speed-up in all supporting techniques, and increased speed in all phases of combat military surveying is essential.

CHAIRMAN HIGBEE: We appreciate your coming here, Mr. Durkin. I know the instrument makers, in particular, appreciate your setting forth the viewpoints and requirements of the armed forces. The public, also, should have some idea of what those viewpoints are, and the differences between them and the requirements of the civilian users. Will you express the thanks of the Technical Session to Mr. Cude and Mr. Shetler for sending you and Mr. Kitchens here for these two ably presented papers. I know that it was a sacrifice, as at this time of the year you are very busy.

In getting information about civilian uses of surveying instruments, we felt that perhaps their use by oil companies embodies as widespread a use of such instruments as any other activity. We asked Mr. G. W. Herzog, who you may remember had quite a bit to say at the meeting last year,—and of course the lightning always strikes where it is drawn—to come back and to prepare a paper. However, at the last minute he got tied up, and he expressed his regrets that he will not be able to be here. We prevailed upon his friend, and likewise an oilman, to pinch-hit for him this morning—Mr. George H. Lacy, Chief Engineer of the Gulf Oil Company.

MR. LACY: Mr. Higbee stated Mr. Herzog was a friend of mine. I don't believe he is, because I talked to him Friday and he told me he couldn't come here, but he didn't even indicate that he was on the program. Mr. Higbee told me yesterday he would like for me to pinch-hit for Mr. Herzog. I haven't had a chance to prepare anything.

There are a couple of gentlemen here who could do a much better job than I—Mr. Rounds of Continental and Mr. Holstein of Magnolia. They are much younger and could probably give you a better description of the uses of instruments in the oil business.

I can't help but think, however, about when I first started out in this work some years ago—too many to name. I remember we were located in a camp. We were on the line at day-light ready to go to work, and we quit after the sun had set. Then we rode back in a wagon or walked to the camp, and had our supper, as we called it.

The transitman plotted his notes—as some of you gentlemen know—at night by lantern light, and he not only plotted them but made the calculations so we would be ready to go to work the next day. So, I think we would have gotten along fine if we had had one of these machines that Mr. Kitchens spoke about and someone to work it.

By telling about a couple of things that happened to me, I might point out things instrument manufacturers might do to improve their transits and levels. When I started out I was head chainman—that is what they called me—and when the transitman got sick they put me on the transit. I don't know why they chose me, unless it was because I am tall and looked like I could handle a transit.

The first hub these boys set was right under

a big nest of wasps which I didn't notice. I was going to show what a good transitman I was, so I rushed up there and set my tripod down, got it over the point and got it level, took my back sight, turned over, and started waving my hands around. The boys got a little forward there and couldn't see me, so I got my handkerchief out and waved it a little too high. The first thing I knew those wasps were all over me. The transit didn't mean a thing to me—I think I ran over it, anyway. When I recovered it, it was on the ground and the telescope looked about like that (indicating). I almost got fired on top of it. I was head chainman from then on.

They might be able to make a transit so that the telescope won't bend when you knock it over.

CHAIRMAN HIGBEE: You are asking for wasp protection.

MR. LACY: During my first experience in Louisiana, I didn't know too much about boats, but we got a boat to cross a bayou about 80 feet wide and 20 feet deep. I didn't stop to calculate the boat's capacity. At the middle of the crossing I was sitting there just wiggling, trying to keep the boat level. Finally, the boat turned over and the transit went to the bottom. Fortunately, one of the boys was a good diver, and he dived down and finally got it out. So the thought occurred to me that maybe you could make a transit that would float.

CHAIRMAN HIGBEE: That is requirement number two now.

MR. LACY: To get down to a little bit more serious business, the oil industry's use of surveying instruments is rather rough. They are more or less pioneers. The geophysicists use transits in locating their shot points and various other points.

Usually oil is in rough country, in the most inaccessible places. After you get as far as you can in a car, you get out and walk or get in a boat. If you carry a transit around in an automobile and if you don't have a shock absorber of some kind, you know it can stand only so much bouncing around in the box.

The gentleman just before me covered infiltration of salt water and dampness. In this low country, even though you have your instrument in the box, a large amount of dampness can get in.

The first thing one notices is that the needle will have some rust spots on it, and on the plate will be a little corrosion that can be seen. When that much can be seen with the naked eye, you know your instrument is in bad shape.

I was interested in one of the instruments on display here. There is quite an improvement in the plate. The glass that covers the plate screws on. I know that in using the old instrument you used to put the glass inside, and then you had a very hard time getting the rim packed in, and if it rained the water came in. I think the new plate is a great improvement in our instruments to date.

In our work, we do a lot of land surveying. Of course, we don't do this work with the accuracy of the Coast and Geodetic Survey or the U. S. Geological Survey, because, in the first place, we don't have time and, in the next place, that accuracy from our point of view is not necessary. If we close a survey with a reasonable closure, it is all right with us. We don't bother about a fraction of a foot in chaining or a minute to a minute and a half in a large traverse.

We do use the needle a great deal. I have had a lot of people ask, "Why do you want a needle on a transit?" Well, in Texas, we have a system of original surveys different from that in any other part of the United States. In the early days, surveyors used the open-sight, peep-sight compass. They did a remarkable job, considering their equipment. However, courses were not exactly as called for in the notes. There are several different reasons for this. One is that maybe they didn't take an observation and check for true north; or maybe they did, and the method was rather crude and they were off some.

When we run a line and finally establish what we call a corrected line of survey, we set off the declination on the instrument and use that line as a base and calculate our course around. We do not use the true course. However, in conjunction with this, we do take the observation and establish true north for mapping purposes.

Some of the old-time surveyors—I have read their notes—had a new declination for each course or each line they ran. That is confusing, but it served their purpose. In other words, the lines would all run east and west or north and south, according to the field notes, but they would change their declination to make the needle read north and south.

The needle is very useful in our work aside from checking calculator courses, azimuths, and so forth.

In southern Louisiana, we have a great deal of triangulation work, because much of that region is impossible to walk over. We usually establish a base line of our own and check into a government triangulation station.

Due to the strong wind there, we use a rather heavy instrument to make it more stable. A lot of these oil fields are located in inland lakes, and if they are not lakes, they are what you call a trembling prairie. Unless you dig a canal or get down a watercourse, you are just out of luck.

As to off-shore drilling, I don't know too

much about that; our company hasn't gotten into that. But I understand they are working on some new methods of locating drilling sites some 30 miles offshore. I think the Stanolind has a light beam for the target, and, of course, they have instruments set on shore to cut this light beam in and establish their point.

I think that is a more reassuring method of locating these drilling sites than some of these new methods such as Shoran and Radar. I understand they have been checked and work fairly well, but I feel that, if I can see a beam out there on my location, I am more sure.

I think that is about all I have on my mind. I am very happy to be here.

CHAIRMAN HIGBEE: Thank you, Mr. Lacy, for pinch-hitting for Mr. Herzog. We appreciate your doing this on short notice. It was very well done.

In the 30-odd years that I have been associated with the instrument industry and attending various technical meetings, there has always been a hesitancy to consider the American instrument maker in the capacity of an engineer. He has usually been thought of more as a peddler than anything else, and I think there has never been an opportunity for the instrument maker really to talk to engineers except in the confines of his own office. There has been a tendency to separate the American instrument makers rather than to draw them together.

There is a great deal of engineering connected with the making of surveying instruments, and I think all of the instrument makers—and that is evidenced by their support of this association—are pleased to come here where they have an opportunity to voice some of their own problems.

Last year someone made the remark that what this section needed was a controversial topic. This was provided during the year, in the October-December issue of SURVEYING AND MAPPING, by an estimable gentleman out in Oregon. I know that I, as well as some of the other instrument makers, were quite "burned up" about the article. That is probably putting it mildly. However, I am not going to trespass upon the dignity of this chairmanship to express any personal remarks. But we do have a very able gentleman here who has long been associated with the instrument industry. He is an engineer, and vice president of one of our oldest concerns. He is Mr. Carl W. Keuffel of Keuffel & Esser Co., and I am sure that he can speak to you ably and well and with interest about some of the problems of the American instrument maker.

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Problems of the American Instrument Maker

By CARL W. KEUFFEL

VICE PRESIDENT, KEUFFEL & ESSER COMPANY, HOBOKEN, N. J.

MR. CHAIRMAN, maybe I wasn't quite as "burned up" about this article you refer to as you, or as some of my associates were, because I feel that I sort of anticipated it by 6 months. The article was entitled, "Just Where Are Our Instrument Makers?" and I assume many of you read it. It was critical of American instrument makers for not offering small light theodolites, optical reading to 1 second of arc, to American users. The article also extolled the virtues of the small tiiting levels with the coincidence bubble-viewing feature.

The question, "Just where are our instrument makers?" was really answered in the meeting we held here a year ago, in June 1948. That was the Eighth Annual Meeting of the American Congress on Surveying and Mapping, and we had a morning session devoted to developments and trends in surveying instruments. A paper by Harold Larson, of Gurley, and one by myself covered this subject. An afternoon session of the Surveying Instruments Division at this meeting was also devoted to this subject.

The surveying instrument manufacturer has always found it difficult to get the surveyor to specify what he desires in an instrument. And why? Mr. Lacy is one of the first men who ever got up in a meeting and told us anything, and, even though we enjoyed his anecdotes, yet we did learn something which I hope we can use next time we design our instruments

or try to improve the design.

We can judge by the results achieved with the conventional American transit over these many years that it has been a fairly satisfactory instrument. The conventional American transit is sturdy in construction and simple in design, is easy to adjust in the field, and has a very long useful life with small maintenance expense. It serves for many purposes and gives remarkably satisfactory and accurate results.

Let us analyze some of the distinctive features of our transit to determine how they affect its good performance.

Take the four-leveling screw-base. Although this is theoretically a poor design, it has proven to be very satisfactory in practice. It is the same thing as having four legs on a table when three legs are theoretically the right thing to have.

With this four-leveling screw-base type of construction, stability does not depend upon the fit of the leveling screws. The threads can be so worn that the screw nearly slides in the nut and yet it is possible to level the instrument quickly and accurately.

Instrument makers have improved the design of leveling screws and made them more dustproof, thus further increasing their useful life. In a three-screw base, stability depends upon the perfect fit of the screws, and, since all screws wear in time, stability of the instrument may be adversely affected.

Then we come to the repeating center. The repeating center of the American transit makes it an all-purpose instrument. A transit reading to 1 minute can measure angles accurately to seconds by repetition. Even when an angle is repeated six times—three one way and three reversed—it is necessary only to read the angle at the first and sixth pointings. An angle read with a direction theodolite at four positions of the circle to eliminate instrumental errors would have to be read eight times.

When measuring angles in a triangulation survey, a direction instrument may be useful, because from any given point a number of angles will be measured—whereas in most surveying practice a single angle is measured. Since the amount of surveying involving triangulation is small compared to the amount involving traverse, an instrument with repeating center is more useful.

It might be pointed out at this time that the high accuracy attained by repetition is made possible by the fact that the error in pointing a telescope is only about one-half second, so that repeated pointings do not accumulate pointing errors of any magnitude. Also, the probable error due to any error in the division of the circle is reduced in direct proportion to the number of repetitions.

I come next to the compass. Many surveyors find it necessary to get magnetic bearings. The design of the conventional transit makes it possible to include a compass with a relatively long needle.

Next is the erecting telescope. The average surveyor spends a large part of his time in "laying out" and "setting line and grade," and for this purpose an erecting telescope has advantages. When measuring angles where targets are used, there is little to choose from between an erect or inverted image. Both erecting and inverting telescopes have been available on American transits for many years, and the demand has always been preponderantly for an erecting telescope.

The telescope bubble makes the American transit more universal in application. It makes it possible to use the transit for leveling in an emergency when a level is not available.

The conventional American transit with four leveling screws, a repeating center, reading by vernier to 1 minute or to 30 seconds, a large compass, and erecting telescope and attached bubble has been used for most of the surveying

done in this country. Its simple design, rugged construction, ease of field adjustment, and long useful life have met the requirements of the American engineer for these many years past.

The American Wye and Dumpy levels, with the 18-inch erecting telescope, have been purchased for many years in large quantities, in spite of the fact that American-made tilting levels with short telescopes and coincidence bubble-viewing methods have been available for about 20 years. The tilting Dumpy level developed in this country has a telescope about 12 inches long and is available in inverting or erecting type. A tilting Dumpy level with still shorter telescope was developed during the war and is also available.

The fact that, in practice, the conventional American transit and level have proven themselves to be highly effective should not and does not keep the instrument maker from working on the development of improved instruments. You have heard representatives of the Army Engineers give some idea of what is going on. They have a very definite program in development, and it is necessary for them to see that they have available sources of supply in this country.

I can give an illustration of what took place in the 1920's and 1930's. In those days the Army and the Navy needed range finders and height finders for antiaircraft use. They could buy these instruments in Europe for five or six thousand dollars or so apiece, maybe seven thousand dollars. In the early 1920's there was only one manufacturer making them in this country, and he was getting around fifteen or sixteen thousand dollars apiece.

Yet it was absolutely necessary for the Army and the Navy to develop sources of supply in this country. They encouraged, as a minimum, two manufacturers to get into the development of these instruments, and as a result the instruments developed were of a more rugged type than the European ones. They were completely sealed, filled with gas, and they would pretty nearly come up to the requirements specified here by Mr. Durkin. And when war came, it was possible for us to go right ahead with the manufacture of the instruments.

At that time, of course, two manufacturers weren't sufficient because the instruments were needed in such large quantities. The drawings were just handed out to about five other manufacturers—to people who had never made range finders before. With the help of the two manufacturers that had the experience, all were able to make very good range finders. And despite the fact that wages nearly doubled in that period, the price of the instruments, when they were made in quantities, got down to about six or seven thousand dollars.

When it comes to developments of this kind, it is necessary for the Army to do something about it in case of emergency. But to get these instruments down to a price so they can be purchased here by engineers in this country is another problem, because of the difference in cost of living in the United States and European countries. That problem, however, may be solved if we ever get to making them in quantity.

In my paper last June, I suggested specifications for an American-made optical-reading universal transit. It must be an instrument with which the greatest number of different surveying operations can be performed. It must be an instrument which has many potential users so that we may eventually be able to manufacture it in reasonably large quantities. In that way the cost will be lowered.

It would be of great advantage to the instrument manufacturer to get the opinions of the surveyor on the features desired in such a universal instrument. Until last year, we had no meetings of

this kind where the manufacturer could get opinions from practical users. Mr. Higbee pointed out that each of us was sort of in his own little cage, doing the best he could. The greatest value of a meeting of this kind is the open discussion on what is desired by the average user.

It is difficult to get the opinions of the average surveyor on his needs and desires as to instruments. The specialist, who is always in the minority, usually publishes the results of his work and describes the instruments he needs. I am talking about the Coast and Geodetic Survey and others who do highly difficult and accurate work. We know what they require, but do we know what the ordinary, everyday surveyor requires? We must cater to the vast majority of users; the instruments must conform to their requirements if we ever want to make them in sufficiently large quantities so that we can incorporate improvements such as glass circle and optical reading.

I hope we can get a little discussion on some of these subjects.

CHAIRMAN HIGBEE: One of the opportunities of being here is this contact beteen the instrument maker and the instrument user. This has several advantages. One is that it gives first-hand information to the instrument makers themselves from regularly constituted representatives; they won't hear by word of mouth or rumor what this fellow is doing and what that fellow is doing, and so forth. I feel that as instrument makers we should be very proud of the progress each may be making; that each is going to contribute something to the general improvement in instruments. To that extent, we should compete only to exceed the other fellow. If we do have this unified feeling of pride in the work we are trying to accomplish, the whole instrument industry is going to profit and you as users of instruments will also profit.

I think we all have reason to feel proud of the work which was done during the war, in spite of our limited horizons, perhaps, at the beginning of the war. The armed forces came forth with many difficult assignments which were met, and generally on time. I think each of us can be proud of the achievements of every other instrument maker in the country, and I feel that those of you who perhaps may not know of those accomplishments and achievements should be equally proud of the work that was done during the war.

In order that we may find out what is taking place in the instrument industry and how much may meet the present-day requirements, the next part of the program will be devoted to hearing from the contributing sponsors who are instrument makers.

We are also pleased to have with us representatives of foreign makers, who are here with their products. They are stimulating us by the leadership they have shown in past years, leadership based upon the demands which they have had upon their resources and abilities. We are pleased to welcome them here and to this meeting, and they will be included among those who will speak to us next.

We have a little time in which we can hear from the representatives of these contributing sponsors. I ask them to tell us as briefly as possible, in 2 or 3 minutes, what they have been doing to add to American instrumentation, and also ask our foreign friends to speak on their accomplishments. I am going to call on them in the order in which they are in the program, and the first one is the Brunson Instrument Company, which is represented here by Mr. W. L. Egy.

DISCUSSION BY INSTRUMENT MANUFACTURERS

MR. EGY: One thing we have been doing that might be of interest to instrument makers and possibly to instrument users is this: Printed word to the contrary, we are still making ball-bearing instruments. Ours are all ball bearing. We were able to procure some additional equipment last year which enabled us to carry measurements beyond those available before. The accuracy required in surveying instruments goes practically one decimal point beyond that which is discussed by the ball-bearing makers themselves. The commercial ball bearing as such for machinery is not suitable for surveying instruments, and while there is a question about the manufacturers being able to go beyond the present accuracy, it just isn't worth the cost to them. So, each instrument maker has to work out his own problem.

There are a number of uses around the country for precise balls or ball bearings that have not been previously available. We have been able to go still further in our measurements this year. We have an elaborate set-up for checking the roundness of balls or their size. It is not so much a matter of actual measurement as it is comparison.

We have little private runways for these balls where they are protected from moisture, dust, temperature changes, etc. We are carrying measurements down very close to a millionth of an inch, and have equipment which will show us comparisons even finer than that. Of course, actually measuring to that degree, as those of you who have tried it know, is more or less problematical.

We have also been able to pick up a prewar German set of dial-gauge measuring equipment which is going to come in very handy to our type of work.

CHAIRMAN HIGBEE: Next in order is the David White Company, represented by Mr. Theodore Salzer.

MR. SALZER: I came here wholly unprepared to talk on the subject of engineering instruments. You are no doubt familiar with the organization I am connected with. We have been striving for years to get the extreme accuracy required in any instrument, regardless of whether it is for the Coast and Geodetic Survey or for the individual engineer.

We have kept abreast of the times regarding the up-to-date equipment; in fact, we have eliminated all the equipment that has been used in the last 10 years. We have revamped our whole organization and gotten new equipment, with rare exceptions, in the last 8 or 10 years. We have a few old machines that are used for polishing. Other than that, the equipment that we are using today is all modern.

CHAIRMAN HIGBEE: Next in order is the Eugene Dietzgen Company, and I believe Mr. C. G. Hess, the New York Manager, is here.

MR. HESS: I came down here unprepared. I felt a little bit like Mr. Higbee felt when I read this controversial article that appeared in the October-December 1948 issue of SURVEYING AND MAPPING. I somewhat resented the fact that this gentleman seemed to allude to the fact that the manufacturers as a whole were asleep. I don't think we are.

Just to point out what Mr. Higbee said, at the beginning of the last war we were called upon to go into production and produce quantities of surveying instruments which, I believe, had never been heard of before. Is that right?

CHAIRMAN HIGBEE: I think you are right.

MR. HESS: We met those demands, and in a great many cases, we were actually ahead of schedule.

Now, one of the dreams I have had for a great many years is that we could design transits and levels like they do motor cars, and probably change an instrument from time to time so that each year we could trade one in. Some day I hope that will be possible. If we ever do it, it will be marvelous.

CHAIRMAN HIGBEE: Next in order is the Henry Wild Surveying Instruments Supply Company of America, Inc. We have all learned to know Mr. A. H. Caesar since he has been over here and we have all learned to like him. May we hear from you now, Mr. Caesar?

MR. CAESAR: I am very pleased to be here. We are vitally interested in your problems of surveying in America. Our managing director has been here now for the last month to learn the problems, which are vastly different from the problems of surveying in Europe, and the application of our instruments to your problems. We will have to modify our instruments to meet your problems.

There are new developments that we have in mind and projected right now. It is hoped these new developments will be of interest to you. I am not at liberty to state exactly what the new ones are, but we have to make new applications to meet modern requirements in photogrammetry, aerial mapping work, ground surveying, and ground control.

I know that there are problems today to cut costs in the field, to meet faster commitments. We hope that, with our new instruments and new developments, this will be possible. We are only beginners here now, and we hope that we will be established for a long time, and that ours will be considered not just foreign instruments, but as closely allied to you as your own instruments.

CHAIRMAN HIGBEE: We have a newcomer in our midst this year who, I think, is here for the first time. That is a rather redundant expression, I will grant you. We are glad to have him. The Hilger & Watts Company is represented by Mr. Stanley, who I think is a principal in the company. Mr. Stanley, will you say something to us this morning?

MR. STANLEY: Thank you for inviting us over. I hope that, in the few remarks I shall make, I shan't mutilate your language too much.

We as a company are continuing to make improvements in our instruments, trying to make them quicker and easier to operate, lighter in weight, more streamlined. That is for two reasons: (1) For sales appearance, and (2) because odd, sticking-out pieces on instruments do get knocked off. So we try to streamline them so that we don't lose quite as many pieces.

We also are paying more and more attention to finish, because we have found that instruments coming back for service after many years look in an awful condition. The chrome and special enamels have helped us give our instruments what we hope will be a lasting finish.

Unfortunately, instruments last far too long, and we are carrying out experiments to find some form of metal which will dissolve in about 5 years.

I was interested to hear the speaker of the Army authorities on this question of standardization. As you all know, there was a meeting held in Canada on standardization of instrument threads, attended by representatives from America, Canada, and the United Kingdom, and I am glad to say they did get somewhere.

We have in our country standardized our screw threads. All transits and levels are interchangeable on tripods. We haven't quite yet standardized our method of mounting with our friends from Switzerland. Probably that will come, but during the war a large number of Swiss instruments were used and we had the job of making adapters. I hope that this standardization will be carried through so that American and British instruments have the same threads.

We had the experience of getting American equipment during the war, and the first heartbreaking thing we had to do was to completely strip a very expensive and good instrument and replace all the threads with the English standard threads; so that the cost to the respective governments went up by about 50 percent.

Another interesting point that I heard in the discussion this morning was on the question of packing instruments. We are paying quite a lot of attention to packing. We are not quite certain that vertical packing, as at present used, is the right solution; we think horizontal packing might have an advantage. It supports the instrument and takes the strain off the centers. We did develop on behalf of the military authorities a case which was airtight and so constructed that it would float. It was also fitted with large silica gel containers which were operated by a valve on the cover so that when the cover was removed the silica gel would not deteriorate and, by using this type of case, instruments could be put into storage and left for many years. They could also be dumped off on the beach and still be in good order.

I don't know what you have in this country. We are perhaps fortunate in that we have an inter-services committee on which the manufacturers sit. When there is any question of a new instrument coming up, we meet with the service departments to discuss their requirements, bring forth the manufacturers' points of view, and then we are able to draw up a specification which meets with service requirements and, we hope, with civilian requirements.

We are doing a lot of development on underground surveying. That is probably due to the fact that our coal mines have been nationalized, and we are now spending the government's rather than the owners' money.

CHAIRMAN HIGBEE: Next in order is the Keuffel & Esser Company, and I believe Mr. Carl Keuffel is going to speak for them.

MR. KEUFFEL: I was interested in Mr. Stanley's remarks, the serious ones and also that little facetious remark about finding a metal which would dissolve in 5 years. We are interested in that, too. But despite our interest in that feature, what we have been doing in the last year or two is trying to improve our instruments so they will have a longer, more useful life.

Those two things are at variance. We would like to have the instrument dissolve in 5 years, but yet what we are actually doing is giving it more useful life by dust-proofing or finding metals and surfaces that wear better, and so on. Maybe it is saying it the wrong way. We are really not interested in a long life; we are interested in keeping the precision as long as possible. The ideal thing would be to have an instrument that is precise and that would keep its precision for 10 or 15 years, then suddenly disintegrate. So, it would serve both the user and the manufacturer.

We have also worked on the optical parts of the instrument, trying to get better definition in the telescope. That is, in general, the work that we have been doing on the conventional instruments. We are also working on instruments of this type, (indicating) mainly for the Army Engineers in development contracts.

CHAIRMAN HIGBEE: Do you want to say something about this theodolite, Mr. Keuffel? I am tremendously pleased that it was turned out by an American instrument maker, and proud of its appearance and characteristics.

MR. KEUFFEL: Well, I don't know that I want to go into any details of the instrument. It was built around the requirements of the Army engineers. They had very concise and precise specifications, and we are not exactly sure that the instrument fulfills all of them. It hasn't gone through all the tests yet. We put it through ourselves, but the Army stilll has some tests to do on it.

It is supposed to withstand the extreme temperature ranges that were mentioned. It will be fungus proof. It is interchangeable with the tribrach which was made by Gurley. We hope it will stand up in actual use; it is so new we don't know too much about it.

Work that the Army is doing in development is important. It is important to the country as a whole that we develop sources of manufacture in this country. While we are doing that we should try to design our instruments so they will be as useful to the general surveyor as they are to the military man. The trouble is that some of these requirements make the instrument so expensive that we have to redesign when we want to sell to the ordinary user.

I don't know how that problem is going to be solved, unless the Army gives us such big contracts that we can design and manufacture it like an automobile. That is what happened with the range finders. They were made in such large quantities that one could break it way down, so that one man did nothing but clean the cross wire, or something like that.

CHAIRMAN HIGBEE: Next on the list is the Marchant Calculating Machine Company. Is Mr. Hough here? I am sorry, apparently he is not.

Next is the Submarine Signal Company. We don't want to get the feeling that this group is completely taken over by the surveying instrument makers, because there are other instrument makers that have a part in surveying, and we welcome the opportunity for them to be here and tell us about what they are doing. Is Mr. Colloton here? He had to go out; he said he would be back.

Then we have the Wallace & Tiernan Products Company, who are making an instrument in the surveying field. They are represented here by Mr. Warren F. Haring.

MR. HARING: Mr. Higbee, I have been impressed by the great effect competition has had on instrumentation over the past 20 years. That is about the span of my experience with instruments. It seems that each time someone comes up with something better, someone else has been pushed a little to the rear and has had to improve his product.

The war also had its influence, and now high labor costs add to the demand for faster, cheaper, more detailed and accurate surveys, and methods of achieving them. In turn, the pressure has been passed along to the manufacture of instruments. It has even reached into the old art of altimetry. Recent advances in altimeters have made possible an accuracy of one-tenth of 1 percent of the change of the instrument. Instruments have been built with a limited range of 2,000 feet giving good readability.

The advancements in the instrument have been ones of simplification—elimination of extraneous parts. Therefore, there is greater sensitivity to changes in elevation. Today we are able to detect pressure changes of less than 1 foot change in elevation.

That takes care of the advancement of the instrument itself. However, one always has to improve his technique or strive in that direction. A new method has been evolved over a period of some 6 years of research and experimentation that is known as the two-base method, wherein one altimeter is placed at a low base or bench mark and another one at a high bench mark in the area. The difference in those two readings gives a calibrated column for reference for field readings.

There are certain conditions, of course, in altimetry. We have stressed the need of surveying by that method only under better atmospheric conditions; we are dependent upon a relatively stable atmosphere. The wind should not be blowing more than 10 miles an hour. The base stations should not be separated more than 10 miles horizontally, and it is preferable to keep vertical separation to within 200 to 500 feet. It is possible to survey from a single set of base stations with accurate results over an area 20 miles square.

So, with those limitations in mind and with the advanced instrument design, actual field results show ability to obtain elevations to within 3 feet, average error; maximum error not exceeding twice that figure. As you can see, it brings that method into 20-foot contour work pretty well.

There are a number of other things in the offing which may help altimetry, one of which is a calculator which will simplify the mathematical computations that have heretofore been made manually. The problem is really one of the solution of similar triangles. The other thing is a means of eliminating manpower at the base stations by the use of recorders.

CHAIRMAN HIGBEE: Next on the list is W. & L. E. Gurley, and we have Mr. C. E. Smart here, who is secretary of the company. Perhaps he can tell us something about what Gurley has been doing.

MR. SMART: During the war one of our customers had a 6-inch vernier compass that had been in the family for over 100 years, and he sent it in and asked to have it repaired. It had been kept in excellent condition. We repaired it and sent it out for the next hundred years. So, the dissolvable program won't work.

The postwar period made us realize that we had a lot of machines that were old, some of them obsolete. We looked into the question of repairing them and found it wasn't feasible. Fortunately, during this time, the manufacturers had brought out heavier, better machines that were easier and faster to use. It is interesting to note that our union had no objection to running these machines at speeds the manufacturers wanted us to run them.

During the past year we ordered, and now have in service, one of the Swiss dividing engines which is more accurate than any dividing engine we have in our factory.

The gentleman from Oregon spoke about reticles. We have been using glass reticles in our instruments since 1943, and, as time has gone along, we think we have improved them. The guided missile and the atomic energy problems have required more and more precise instruments, and so far we have been able to bring the reticles to their specifications.

The other thing I would like to talk about is our solar transit, which is being used more and more. The Land Office has a number of them, and we are beginning to send them to other customers throughout the United States.

CHAIRMAN HIGBEE: Is Mr. Reed here? (No response.)

That concludes the contributions of the instrument makers. I hope that the instrument users here are impressed by the array of talent behind the instrument industry. It is not proposed that they take up the entire program. We are now going to give an opportunity for the instrument users to contribute something to this program, perhaps extemporaneously. If you have any questions of a non-controversial nature—the time is getting late—let's have them.

DISCUSSION BY INSTRUMENT USERS

MR. WILLIAM B. HOKE (Bureau of Surveys, Baltimore, Md.): I feel impelled to speak this morning because I am neither fish nor fowl at these meetings. I am neither a member of the government nor am I a private surveyor. I am simply chief of the survey division of a large municipality. We do all the kinds of work that have been mentioned, from triangulation down to the location of a hub on somebody's corner. However, most of our work is plotted to a scale of 40 feet to the inch, and all positions are computed to the nearest hundredth of a foot. So I am familiar with practically all the problems in some degree.

I would like to make a few comments here. One is that our instrument manufacturer friends would find out more about the use of their instruments if, instead of sending salesmen to see you, they would send engineers. I don't know how many times I have spoken of these same improvements over the last 20 years. I usually get some agreement but never action. I will commend Mr. Drew over there. Once I mentioned a problem to him, and within 2 weeks he had completed the solution of it and it was all straightened out. I will commend Mr. Keuffel for his instrument, which I find to be very satisfactory and stable, and does excellent work. However, in operations, we find two or three peculiarities or things that just don't work out right. One is that the instrumentman should be able to see every scale and every action of his transit from his position behind the eyepiece, and not have to walk around to read circles. Mr. Keuffel told me last year that that could be solved but it would cost some money.

MR. KEUFFEL: It is right there.

MR. HOKE: That is true. The other thing we find is that the tangent clamp down below is invariably the source of trouble when things go wrong. It is the one place that gets dirty, that gets full of dust, and if something could be found to eliminate that, I think it would help.

I also mentioned last year that the vertical circle could probably be made so that one wouldn't have to stand up and read straight down on it. I know one of the criticisms I had of the Gurley transit was that I knocked my hat off every time I tried to read the circle.

I like rigidity in the tripod. We have a number of old instruments, and the tripods are the things that go bad first. We have developed all sorts of greasing compounds, special washes, and things like that to keep them from being wobbly on the tops, but, until this new wide-spread head came along, we always had trouble.

I may have a few other ideas but I can't give them right at this moment. But I would like to talk with other people in the group here who are representatives of municipalities and have the same problems I do, because I sort of feel lost between the two groups. Maybe we can get together on some of these things.

CHAIRMAN HIGBEE: Well, that is all very interesting, and those are the things we are trying to bring out in these meetings. We appreciate your free expression. Does anyone else feel the spirit upon them?

MR. W. N. BROWN (Washington, D. C.): I merely want to emphasize or reinforce one point that the previous speaker made, and that is the advisability of being able to read all the functions of the instrument from the position in the rear. It may cost a little more, but the instrument maker should remember that a good accurate transitman will take from three to four hundred shots a day, and every time he has to step around that instrument to read the vertical circle, it really means something in dollars and cents to the operation. I think it would be economy in the end if they could make

the instrument so that he could read it from one position.

MR. KEUFFEL: May I ask a question, or are only they allowed to speak?

CHAIRMAN HIGBEE: Go ahead.

MR. KEUFFEL: I would like to ask these users this question. I feel it is important, and this instrument will do what you say. But why, if that is so important, haven't the American users made use of the tilting Dumpy level with the bubble feature, with which one can do everything and watch his level every second of the time? That has been available, but the number we sell are so few that the cost is still high. Why is that?

MR. BROWN: I don't think many people are using it. I am speaking of the ordinary field of surveying.

MR. HOKE: I can answer Mr. Keuffel by stating that we have an old level down at the office that has the mirror reflection so that one may read the bubble from the eyepiece end. But what I was speaking of—and I think Mr. Brown over there was too—is that, when you are out taking topography, speed is a requisite and you must really get going. And if a man is craning his neck three or four hundred times a day to read the plate, the arc, the rod—

MR. BROWN (Interposing): And he has got to step around the darned thing.

CHAIRMAN HIGBEE: Do you mind if I have something to say on that subject? I don't want to trespass upon my position here, but I have had 30-odd years' experience in calling upon engineers in the field. Incidentally, I am an engineer, Mr. Hoke, and, as a matter fact, every salesman we have sent out for the last 20 years has been an engineer.

We make a practice of investigating complaints. We get complaints; we don't make perfect instruments. But we do like to investigate those complaints because we learn from them.

Only 2 weeks ago, I was out on a job with a man using a level, and I took one of these precise tilting levels out with me and tried to get him to use it because he had a particularly trying job, but he was afraid to use it. And that, I think, is the answer to why there is not more use of the tilting type of level in the country. In the first place, they expect the level to reverse, and, if it doesn't reverse, the average engineer is lost; he doesn't know what to do. He has no appreciation of the fact that the only important adjustment in the level is that the bubble be parallel to the line of collimation and that the bubble be in the center at the time he takes a reading. He doesn't understand those fundamental characteristics of leveling, and, until he does understand them thoroughly and is not afraid to use a level which doesn't reverse when turned around, he is not going to use the tilting type of level.

One reason they have never used the coincidence-bubble type of instrument is because they want to hurry and do the job and sling it over their shoulders and walk up to the next set-up and set it up quickly. Carrying it in that position, the coincidence type of bubble is likely to change its length because it usually is a chambered vial. Am I correct in that, Mr. Keuffel?

MR. KEUFFEL: Both are available.

CHAIRMAN HIGBEE: The constant-length bubble is now available, but it hasn't been. And I can go back 20 years to when that type of level was being made by Bausch & Lomb and put on the market, and I can go back to the period when many of these things were being made and put on the market. But they were not accepted by the average surveyor or engineer who pays the bills and keeps us on our jobs. We have lost a lot of money trying to sell the things we are putting on our instruments today. It takes a long time to promote these improvements.

But the fact is that there was not available at that time the constant-length bubble. They had a chambered vial and one had to keep the length of the bubble within the field of view of his optical prism system, and that required a chambered vial. In carrying it from set-up to set-up, that length of bubble would get changed. It was a source of annoyance, of course, to the instrumentman, and the tilting type of level did not become popular for that reason.

MR. WILLIAM A. REYNOLDS (Connecticut Highway Department, Hamden, Conn.): I would like to ask how the optical-type transit holds its adjustment in comparison with the old-fashioned conventional type, which most of us are using, and if, when it is out of adjustment, it can be put back into adjustment with the same ease which the conventional type of transit may be adjusted?

CHAIRMAN HIGBEE: We have two people here who can answer that. One is Mr. Caesar and the other is Mr. Keuffel.

MR. KEUFFEL: I think one answer is that an instrument does not have to be in perfect adjustment. I am an instrument maker. Maybe you think that is an alibi for an instrument maker, but it isn't. The methods of procedure in surveying should be such—and I think they are—that an instrument does not have to be right on the hair. I think every surveyor knows that, but he always tries to get that plate bubble just right, when it isn't a bit necessary, because when he plunges in reverse it doesn't matter.

And even there, unless he takes from very high to very low in getting an angle, it is of such third-order accuracy that it wouldn't affect the angle.

As to whether the glass-circle instruments keep in adjustment better than the others, I can only say that they must keep in good adjustment because they keep on selling.

MR. REYNOLDS: That answers part of my question. Now, as to putting it back into adjustment—

MR. KEUFFEL: That would be for Mr. Caesar.

MR. CAESAR: The adjustment of the instrument is very simple. There are several users here in the room. I think Mr. Kelly of Aero Service Corporation uses some of our instruments and knows how they stand up. The adjustments are simple to get to, and, as for the internal adjustments, the instrument is not made to be internally adjusted. There should be, say, lubrication of the main axis of the instrument once in 3 years, but we advise that it should be done by an experienced man.

The normal adjustments to your levels can be made just as easily as on any other instrument, and they are readily available to you. I would be pleased to show you an instrument and how it can be done.

CHAIRMAN HIGBEE: I might add a little something to that. The Army specifications are quite rigid because these optical-type instruments will be used by men who are entirely inexperienced in their use, and one of the requirements is that the adjustments be readily available and easily made.

Well, it is 11:30 o'clock now. I know there is a lot more. Do you want to continue this meeting a little longer and run to 12 o'clock? I think we are just getting warm right now.

PROF. HARRY BOUCHARD (University of Michigan): I would like to tell Mr. Keuffel one reason why it is desirable to continue the manufacture of inverting eyepieces. There are many such instruments in common use, and should be supplied to educational institutions. I had occasion some 10 or 12 years ago to loan an instrument to a member of the staff of the university where I am who supposedly had had engineering training, but who got sidetracked and was teaching history. He owned a summer cottage where he wanted to make a survey over the week end. He came to me on Friday and asked to borrow a transit. He brought it back bright and early Monday morning and said he was awfully sorry but some student apparently had taken out some of the lenses because, when he looked through there, everything was upside down.

We hope any graduate of the University of Michigan has become familiar with inverting eyepieces and doesn't pull a boner like that.

Just one other thing, and that is a compliment to some of you makers of surveying equipment. We have transits at the university which are as old as I, and I have had a sixtieth birthday. In a sense it is a shame to allow students to use such aged instruments. On the other hand, they are in just as good condition, having been taken care of, as some of our brand new ones. It is an out-and-out shame to turn over an instrument of that sort, or even one intended for just ordinary use, which is brand new, to a student who never has seen or touched such equipment. We don't feel quite so bad about turning over these older instruments.

We have fairly large classes, and it is impossible to give individual attention to every student and watch him the first time he takes an instrument out of the box, attaches it to a tripod, and starts turning screws. But those instruments of 60 years, and a number of drilling instruments which are practically 40 years old, have been in constant use. They have gotten perhaps not quite as rough use as some of Mr. Lacy's equipment, but they have been handled by inexperienced people year after year. About the time they become proficient and trained in handling an instrument, they are gone and a new group will come along.

MR. LACY: As a user of instruments, I have heard a lot of criticism, and I want to go right along with a few compliments. The instrument manufacturers should be commended on the durability of their instruments. Our company was organized in 1901, I believe. We have four transits that were bought then, and those transits are sent to the factory periodically, worn parts are replaced, and they are cleaned up. If I were using transits, I would just as soon have one of those as a new one. I would rather have it because I am more familiar with it.

I got a little disturbed a while ago when you fellows were saying these instruments ought to be replaced every 5 or 10 years, because I have some more that I want to have repaired and used. So I think you had better go along just as you are.

Our instrument makers—I am not familiar with any foreign makes—have done a swell job on the types of instruments that have been produced. I have seen some transits that dated a little further back than ours. I don't know the date, but I know the first one I ever used was a great big Gurley that had a tremendous plate; you could read that without a glass or anything. However, the weight was against it, because when you carried that all day you had really done a job.

I am glad you are thinking about reducing the

weight of your instruments, because it is quite a job to carry those around all day, and it will be very helpful if we can get the same results with lighter instruments.

CHAIRMAN HIGBEE: When I look at Mr. Lacy and Mr. Rounds and Mr. Holstein and some of these fellows from Texas who have been carrying these old heavy instruments around for so many years, I have a feeling that that is what helped build them up and make them so big and strong.

MR. JOSEPH G. KELLEY (Aero Service Company, Philadelphia, Pa.): I would like to discuss first, the adjustment in the instruments which was mentioned. We have several T-3's, a T-2 and a T-1, and the field adjustment is much simpler than in the American-made instruments. There is only one plate level, so there is only the necessity of adjusting one plate bubble. There is the collimation level or vertical-circle bubble, and there is only one adjustment to that. We never had occasion to adjust the reticle. So, there are only two simple adjustments in the field use of the instrument.

With regard to the controversy between the American viewpoint—at least the manufacturer's viewpoint—and those ideas imported from Europe, we are, of course, in the contract business. Mr. Brown has brought out a point that our automobile manufacturers and other people have been well aware of for many years, but which the surveyor has never quite caught up to. That is, in your field progress on a competing basis, you must be aware of saving every possible minute. A minute for a transit party is worth about 5 cents. I believe it will probably run 8 cents or better; for a level party, it will run around 5 cents. It doesn't take long to make a dollar out of those minutes.

Saving every bit of your observer's time is a big factor in reducing your costs. I don't know if our American manufacturers have conceived the relationship between cost and operation of the instrument, but it is vital to our way of operating.

There are other things that I think could be approached even before we reach the instrument stage. There are little devices that we use now, without thinking much about them, that were never designed for the use of the surveyor. The tension handle no doubt was originally devised to measure the weight of fish or some similar product; it certainly wasn't designed for the man who is going to measure the tension on a tape.

I feel that, with the greater precision and the speed up in accuracy and production that is required of the man in the field, a tension handle should be devised which would fit in the palm of the hand and be very close to the tape. At present, the tension handle is over here (indicating) and the tape measurement numbers are about here (indicating), requiring, if one man is to use the tension handle, a glance at the tape and the tension handle at the same time. There is a resultant decrease in the accuracy of both the measurement of the tension handle and the marking on the tape, and it is a needless waste.

What I feel we ought to have is a tension handle for all around purposes. It would fit in the palm of the hand; it would buzz or ring or something of that sort when the right tension is applied so the man wouldn't have to look at it. That is saving time, it is saving hours, it is increasing accuracy. It should be all-purpose in regard to its use in any weather, winter or summer, with gloves or with the open hand. I feel that the tape should go through possibly two fingers, so that two-finger gloves can be used in winter.

If I were to develop it in my own shop, it would cost a terrific amount, but if a manufacturer could come out with something like that and create a universal demand, it would be helpful to the man in the field. The first manufacturer that would push it would probably make something out of it.

MR. BROWN: Could that be done by an unbreakable thermometer?

MR. KELLEY: Yes.

CHAIRMAN HIGBEE: Mr. Abrams, have you any contributions to make to this meeting?

MR. TALBERT ABRAMS (Abrams Aerial Survey, Lansing, Mich.): Thanks for asking me. My interests are aerial surveying and photogrammetric instruments. I don't think this is quite the place to give a sales talk on photogrammetric methods. But I am very interested. The thing that Mr. Kelley brought up is probably the most important thing that we have to contend with, that is the economics of time. If you can save a minute for a crew by having a better instrument, you can pay almost any kind of price for it because you can write it off in a short time.

If you people who are actively surveying in the field would write letters to all the instrument manufacturers every time you have a problem—just sit down and make five copies which go to the five principal instrument makers—and tell them what it is, you would get a story across and in a short time you would begin to get some action in getting the kind of instrument you want.

CHAIRMAN HIGBEE: We also have Mr. Ellis here, who is the chairman of the Federal Specification Committee. Would you like to say something to us, Mr. Ellis?

MR. W. T. ELLIS (Department of Agri-

culture): The thing that impresses me most about this meeting, Mr. Higbee, is the brotherly love and affection among the instrument makers. I never had noticed it to this degree before, and I am getting worried. I am afraid if I wanted to buy an instrument this morning, I couldn't find anybody to sell it to me. I think he might send me to his competitor and say, "He has a better instrument."

I have enjoyed the session this morning. A lot of good will comes out of these meetings. Of course, we government people are users primarily, not designers, though the military services are an exception.

I think the points that Mr. Abrams has brought out are very pertinent. I don't believe we realize the value of time. We insist our instrument manufacturers produce a better instrument, but we are not willing to pay the price in terms of original investment. We don't realize to a sufficient degree that time saved pays for that instrument, and that its cost is very low in proportion to the cost of total operation.

CHAIRMAN HIGBEE: I don't like to shut off this discussion because it is very interesting and the type of thing which we as instrument makers are all keen to get. We never resent honest criticism based upon honest observation and experience.

While we have our own ways of getting at each other when we are outside of here, we are in coordination here, and as we get better acquainted we are going to have a healthier respect for each other's abilities, and that is a healthy sign.

In the last year I have been directing—I am not trying to pin a halo on myself—inquiries for optical-reading instruments to Mr. Caesar. During the past few years I have been directing inquiries for certain types of instruments to Mr. Berger because I felt he could do a better job than we on those particular instruments. I have no recollection of sending any inquiries to Keuffel & Esser except on slide rules. But we have been together on certain things, and we have a healthy respect for their abilities, as we have for the Dietzgen Company and other instrument makers in the field. Each has his own specialty and is honestly trying to give the instrument users better equipment.

The instrument business has been so small it has had to use by-products of many other industries and make its own special equipment or try to make over equipment developed by more prolific industries. We have been handicapped through the years by this procedure.

REPORT OF NOMINATING COMMITTEE

The Technical Division on Surveying Instruments got started by presidential appointment, you might say, and I have felt we should get ourselves organized a little better. For that purpose I have appointed a nominating committee consisting of Messrs. W. N. Brown, W. L. Egy, and R. M. Berry to consider the type of structure we should have and to come before this meeting with recommendations. I hope this meets with your approval. I ask Mr. Brown to make a report on the findings of that committee.

MR. BROWN: I think we have all heard it said that a poor workman complains of his tools. I don't know how true that is but it is not usually a group like this that has any real complaint about the instruments that the instrument men are making for us. I find it is usually the backwoods, country surveyor and that type of man who is always complaining about his instrument; that his errors are due to the instrument and not to himself.

Therefore, the nominating committee thinks the officers will have the job of educating, not those who attend conferences, but those who stay back home. So, in selecting our candidates, we kept in mind the advantage of diversity. We tried to spread the nominees over the country so they would have a chance to know the problems of their immediate sections and how to meet them.

The committee thought there should be a Chairman, a Vice Chairman, a Secretary-Treasurer, and an Advisory Council, which is going to have to do a great deal of the work in the educational program. For Chairman we nominate Mr. L. C. Higbee and for Vice Chairman, Mr. Carl W. Keuffel. I understand that whoever was to interview you, Mr. Keuffel, didn't get to ask whether you would serve or not. We hope you will serve, sir.

MR. KEUFFEL: I will be glad to.

MR. BROWN: For Secretary-Treasurer we nominate Mr. L. E. Demier. For the Advisory Council, we divided them into groups; that is, instrument makers, representatives from government agencies, professional people, and representatives of educational institutions. For the instrument makers, we nominate Mr. W. L. Egy and Mr. A. H. Caesar; for the government agencies, Mr. C. R. Manor of the U. S. Engineers and Mr. W. T. Ellis of the Department of agriculture.

CHAIRMAN HIGBEE: Mr. Lindsay, may I ask you to take the chair while this business session is proceeding?

(Mr. C. C. Lindsay took the chair.)

MR. BROWN: The practicing professional men nominated are Mr. W. P. Moore of Phillips Petroleum; and Messrs. J. G. Kelley and C. C. Lindsay of Canada. For the educational institutions, we nominate Prof. M. C. May of the University of New Mexico and Prof. Paul Rice of Rutgers College.

That completes the nominations. There are seven men on the Advisory Council and three officers—the Chairman, Vice Chairman, and Secretary-Treasurer. The committee had difficulty in making its decision because we couldn't put on all the people we wanted. We did the best we could, and hope it meets with your approval.

CHAIRMAN LINDSAY: Mr. Brown, you make a motion that these nominations be accepted, and it is seconded by Mr. Berry; is that correct?

MR. BROWN: Yes.

CHAIRMAN LINDSAY: Gentlemen, we have a motion that this list of candidates be accepted. All in favor please signify in the usual manner by raising the right hand; contrary, if any. The motion is carried.

(Mr. Higbee took the chair.)

CHAIRMAN HIGBEE: Thank you very much, Mr. Lindsay. I was rather loath to continue as Chairman, but, in order to keep a continuing coordination of the activities of this committee and to pass on what little experience I have had so far, I did accept. I appreciate the compliments of the committee and yourselves in officially electing me; I feel that I have my feet on the ground now, rather than just a temporary appointee.

It is nearly 12 o'clock. It is interesting that you were sufficiently intrigued by the program to continue this discussion. I am sure it is one which could be carried on in a bull session for many hours. However, it is 2 minutes of 12. You have been very patient, attentive, and interesting. Thanks to all of you for coming, and thanks to you who helped present this program. I now entertain a motion to adjourn.

MR. LINDSAY: Before that motion, I would like to request a vote of thanks to the Chairman for the excellent manner in which he conducted this meeting. It has been exceedingly interesting and we have all enjoyed it very, very much indeed.

CHAIRMAN HIGBEE: Thank you very much, Mr. Lindsay.

(The meeting adjourned at 12 o'clock.)

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Financial Statement

(As of December 31, 1949)

INCOME

	1948	1949	Year ending 12/31/48	Year ending 12/31/49	Differences
Dues and memberships received					
Individual	1052	1239	$5,340.42	$6,241.75	
Library	109	158	452.25	658.25	
Sustaining	10	13	250.00	325.00	
Subscriptions	0	4	0.00	19.00	
Total	1171	1414			
Total gross regular income			$6,042.67	$7,244.00	+$1,201.33
Deduct membership costs			*– 562.65*	*– 571.45*	
Net regular income			$5,480.02	$6,872.55	+ 1,392.53
Publication sales			92.46	113.97	+ 21.51
Annual meeting and other income			*– 165.48*	876.13	+ 1,041.61
OPERATING INCOME			$5,407.00	$7,862.65	+$2,455.65

EXPENDITURES

Journal (all expenses)			$4,743.92	$4,952.24	+$ 208.32
Other printing			151.08	150.45	– *.63*
Office supplies and Secretary's and Treasurer's expenses			821.04	707.76	– *113.28*
Technical Divisions			80.00	18.05	– *61.95*
Testimonial to Secretary			100.00	0.00	– *100.00*
President's travel to U. N. meeting			0.00	146.17	+ 146.17
TOTAL EXPENDITURES			$5,896.04	$5,974.67	+$ 78.63
SURPLUS (or deficit)			– 489.04	+1,887.98	+ 2,377.02

ASSETS

Bank balance			$2,852.28	$4,879.84	+$2,027.56
Journal (back issues—estimated)			300.00	300.00	0.00
Emblems (at cost)			122.09	77.09	– *45.00*
Dues receivable			187.00	0.00	– *187.00*
Accounts receivable			130.50	76.17	– *54.33*
TOTAL ASSETS			$3,591.87	$5,333.10	+$1,741.23

LIABILITIES

Advance dues paid			$ 301.25	$ 594.31	+$ 293.06
Oct.–Dec. Journal			1,305.54	1,200.00	– *105.54*
Other accounts payable			665.27	331.00	– *334.27*
TOTAL LIABILITIES			$2,272.06	$2,125.31	–$ *146.75*
NET WORTH OF CONGRESS			$1,319.81	$3,207.79	+$1,887.98

SUSTAINING MEMBERS

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AIR SURVEY CORPORATION
Photogrammetric Engineers
3203 O St., N.W., Washington, D. C.

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